Ontario

Ministry of Transportation

Materials Engineering and Research Office Report

Aggregate and Soil Proficiency Sample Testing Program for 2006

MERO-025

Technical Report Documentation Page

Publication Title	**Aggregate and Soil Proficiency Sample Testing Program for 2006**
Author(s)	Mark Vasavithasan, Chris Rogers
Originating Office	Soils and Aggregates Section, Materials Engineering and Research Office
Report Number	MERO-025; ISBN 978-1-4249-3124-8
Publication Date	January, 2007
Ministry Contact	Soils and Aggregates Section, Materials Engineering and Research Office, Ontario Ministry of Transportation, Room 220, Building C, 1201 Wilson Avenue, Downsview, Ontario, Canada M3M 1J8 Tel: (416) 235-3735; Fax: (416) 235-4101
Abstract	The Materials Engineering and Research Office, Soils and Aggregates Section, runs a proficiency sample testing program each year to provide a means for participating laboratories to see if they are performing satisfactorily. We also conduct a sample-testing program along with our annual proficiency program, for the tests related to Superpave consensus properties of aggregates. The laboratories are asked to perform a number of different tests on pairs of samples that have been prepared and randomly selected at the MTO Laboratory. The samples are delivered to the participating laboratories starting in June and they report their results for the aggregate and soil proficiency sample tests starting in the early part of August. A preliminary report issued in early September allows the laboratories to examine their procedures or equipment and correct any problems that may have occurred. This is the final report for both, the Aggregate and Soil Proficiency Samples and Superpave Consensus Property Testing for 2006. This year there were two hundred and ten laboratories participating from the private and public sector in the Aggregate and Soil Proficiency Sample Testing Program. Fifty-seven laboratories from the private sector and MTO Downsview laboratory reported results for the Superpave consensus property tests. Results of the 2006 Proficiency Sample Program are found to be consistent with the results reported in the last three years but in some of the tests, the variations show noticeable improvements compared to previous years' results. Although there is noticeable improvement in results, strong laboratory biases still remain in many of the test procedures. The variations in the results for consensus property testing program are comparable to the values published in ASTM precision statements.
Key Words	Aggregate, consensus property, correlation, laboratory, proficiency testing, soil, Superpave
Distribution	Unrestricted technical audience

Ontario

Ministry of Transportation
Materials Engineering and Research Office Report

MERO-025

Aggregate and Soil Proficiency Sample Testing Program for 2006

January 2007

Prepared by:
Mark Vasavithasan and Chris Rogers
Materials Engineering and Research Office
Soils and Aggregates Section
Ontario Ministry of Transportation

1201Wilson Avenue,
Downsview, Ontario, Canada M3M 1J8
Tel: (416) 235-3735; Fax (416) 235-4101

Published without prejudice as to the application of the findings.
Crown copyright reserved

2007-01768/

Table of Contents

Executive Summary iv
1. Introduction 1
2. Test Results 3
2.1 Table Of Test Results 3
2.2 Scatter Diagrams 4
2.3 Outliers 10
3. Discussion 11
3.1 Notes On Material Sources 11
3.2 Notes On Sample Preparation 11
3.3 Notes On Individual Tests 12
3.4 Proficiency Sample Tests 12
3.4.1 Wash Pass 75 µm (Coarse Aggregate) – Test No. 1 12
3.4.2 Sieve Analysis (Coarse Aggregate) – Test Nos. 2-6 13
3.4.3 Los Angeles Abrasion Loss (Coarse Aggregate) – Test No. 8 13
3.4.4 Relative Density (Coarse Aggregate) - Test No. 9 and 14
Absorption (Coarse Aggregate) – Test No. 10 14
3.4.5 Magnesium Sulphate Soundness (Coarse Aggregate) – Test No. 11 14
3.4.6 Percent Crushed Particles – Test No. 12 and 15
Percent Cemented Particles – Test No. 7 15
3.4.7 Percent Flat and Elongated Particles – Test No. 13 15
3.4.8 Petrographic Number (Concrete) – Test No. 14 16
3.4.9 Petrographic Analysis (Fine Aggregate) 17
3.4.10 Micro-Deval Abrasion (Coarse Aggregate) – Test No. 16 18
3.4.11 Freeze-Thaw Loss – Test No. 17 18
3.4.12 Sieve Analysis (Fine Aggregate) – Test No. 20-25 19
3.4.13 Relative Density (Fine Aggregate) – Test No. 27 and 19
Absorption (Fine Aggregate) – Test No. 28 19
3.4.14 Magnesium Sulphate Soundness (Fine Aggregate) – Test No. 29 20
3.4.15 Amount of Asphalt Coated Particles in Coarse Aggregate – Test No. 30 20
3.4.16 Moisture-Density Relationship (One-Point Method) – Test Nos. 31-33 21
3.4.17 Micro-Deval Abrasion (Fine Aggregate) – Test No. 34 21
3.4.18 Particle Size Analysis of Soil – Test Nos. 40-45 21
3.4.19 Atterberg Limits of Soil – Test Nos. 46-48 22
3.4.20 Specific Gravity of Soils – Test No. 49 22
3.5 Superpave Consensus Property Tests 23
3.5.1 Uncompacted Void Content (FA) – Test No. 95 23
3.5.2 Sand Equivalent Value of Fine Aggregate – Test No. 96 24
3.5.3 Percent of Fractured Particles in Coarse Aggregate – Test No. 97 24
3.5.4 Percent Flat and Elongated Particles in Coarse Aggregate – Test No. 99 25
4. Laboratory Rating System 26
5. Conclusions 29
6. Recommendations 30
7. Acknowledgments 31
References 32
Appendix A: Glossary of Terms 33

Appendix B1: List of Participants 35
Appendix B2: List of Participants 48
Appendix C: Multi-Laboratory Precision 51
Appendix D1: Scatter Diagrams 57
Appendix D2: Scatter Diagrams 95
Appendix E1: Production Laboratory Ratings 99
Appendix E2: Full Service Aggregate Laboratory Ratings 104
Appendix E3: Soil Laboratory Ratings 106
Appendix E4: Superpave Laboratory Ratings 107

List of Tables

Table 1. Summary of Results for Laboratory 47 5
Table 2. Summary of Results for Laboratory 47 6
Table 3. Summary of Results for Laboratory 47 7
Table 4. Summary of Results for Laboratory 47 8

List of Figures

Figure 1. Examples of Scatter Diagrams 9
Figure 2. Multi-Laboratory Variation of Percent Flat and Elongated Particles Test 16
Figure 3. Fine Aggregate Petrographic Examination Scatter Diagrams 18
Figure 4. Laboratory Ratings 27
Figure 5. Superpave Laboratory Ratings 28

Executive Summary

The Soils and Aggregates Section of the Materials Engineering and Research Office, runs an annual proficiency sample-testing program for aggregate and soil tests. This provides a means for participating laboratories to see if they are performing satisfactorily. The laboratories are asked to perform a number of different tests on pairs of samples that have been prepared and randomly selected by the Soils and Aggregates Laboratory. The samples are delivered to the participating laboratories starting in June. The laboratories report their results in August. A preliminary report issued in early September, gives feedback to the participants while they are still operational in the current year. This allows them to examine their procedures or equipment and correct any problems that may have occurred. A final report is issued after analysis of the data has been completed.

In addition to our annual correlation program, the Soils and Aggregates Section is also conducting a proficiency sample-testing program for the tests related to Superpave Aggregate Consensus properties. This is conducted along with the MTO Aggregate and Soil Proficiency Sample Testing Program. The participants in consensus property tests are requested to perform four tests on the same aggregates that are supplied for the annual aggregate and soil proficiency program. The laboratories report their results for this program in early October.

This is the final report for the 2006 MTO Aggregate and Soil Proficiency Sample Testing and the Superpave Aggregate Consensus Property Testing Programs. This year, there were two hundred and ten (210) laboratories from the private and public sector participating in the Aggregate and Soil Proficiency Sample Testing Program. Of these, one hundred and fifty were aggregate producer's and road builder's Quality Control (QC) Laboratories. The remainder were engineering testing consultants and owner's laboratories. Participation in this program is required by the contract documents if contractors QC process is to be acceptable to MTO. In general, these laboratories are conducting particle size analysis, wash pass 75 μm, percent crushed particles, percent asphalt coated particles, and density tests for granular base and sub-base aggregates.

Fifty-seven laboratories from the private sector reported results for the Superpave Aggregate Consensus Property Testing Program in 2006. The laboratories that participate in this program conduct uncompacted void content of fine aggregate, sand equivalent value of fine aggregate, percent of fractured particles in coarse aggregate, and flat particles, elongated particles, or flat and elongated particles in coarse aggregate tests, in accordance with the ASTM/AASHTO test methods.

Reports to individual laboratories contain ratings for each test method, which are based on the standardized deviate for that test (*i.e.* a rating of 5 for data within 1.0 standard deviation of the mean, a rating of 0 for data 3.0 or more standard deviations from the mean). Ratings of each test method are also used to calculate an overall laboratory rating for each category of tests. This rating system has acted as an incentive for laboratories to improve their

performance.

Results of the 2006 Proficiency Sample Program are more or less consistent with results from previous years and in some of these tests, the results show noticeable improvements compared to previous years' results. Particularly, percent crushed particles, freeze-thaw, magnesium sulphate soundness (fine), and Micro-Deval (coarse) show improvements over previous years. This is likely due, in part, to the laboratory improvements brought about by the Canadian Council of Independent Laboratories (CCIL) lab inspection program, for the Aggregate Laboratories. Although there is noticeable improvement in the precision of most of the test methods compared to previous years, strong laboratory biases still remain in some of the test methods. The variations in soil test results are consistent with the values reported in the previous four years of study, but the scatter plots show a strong laboratory bias.

The number of participants in the Superpave aggregate consensus property testing program has risen from twenty in 2002 to fifty-seven in 2005. The majority of the laboratories who, participated in the 2006 Superpave aggregate tests have now gained experience with these test procedures. The variations for all of the tests are comparable to the values published in ASTM precision statements. However, the scatter diagrams for all four tests show strong laboratory biases.

The Soils and Aggregates Section, continues to carry out the on-site inspection of soil-testing laboratories in an effort to improve the quality of testing services provided to the ministry. This inspection is being done at the request of laboratories. The laboratories that are inspected and accepted by MTO must request a re-inspection whenever the technician(s) or equipment changes. To date, thirty-eight laboratories have been inspected, of which thirty-three laboratories have been approved to do testing of soils for MTO work.

1. Introduction

This is the final report of an annual inter-laboratory testing program organised by MTO for aggregate and soil test methods. It is primarily intended to provide a means for laboratories used by MTO to see if they are performing satisfactorily and to qualify these laboratories to perform quality control and quality assurance testing for MTO contracts[1]. The design of the testing program is based on procedures for determining the precision and variability of test methods. Interested readers should refer to ASTM C670[2], C802[3], E177[4] and E178[5] for further information on inter-laboratory testing programs.

There were a total of two hundred and ten laboratories participating in the Aggregate and Soil Proficiency Sample Testing Program, conducted in the summer of 2006. The participants were also asked to submit results for Superpave aggregate consensus property tests, if they were equipped to perform those tests. Fifty-five laboratories submitted results for the tests related to the consensus properties. Participants in both testing programs included the MTO laboratory, the remainder being from the private sector (contractors, aggregate producers and engineering consultants) and municipalities. Samples were delivered to laboratories in June. A preliminary report for Proficiency Sample Testing Program was issued in early September. This document is the final report for both programs.

Reports to individual laboratories contain ratings for each test method, which are based on the standardized deviate for that test (*i.e.* a rating of 5 for data within 1.0 standard deviation of the mean, a rating of 0 for data 3.0 or more standard deviations from the mean). Ratings of each test method are also used to calculate an overall laboratory rating. This rating system has acted as an incentive for laboratories to improve their performance.

The computer program that was developed to handle the computation and presentation of test data has two statistical methods, namely the Critical Value Method and the Iterative (Jack Knife) Technique, to detect outlying observations or outliers in a set of data. For details of the program refer to the User's Manual (MERO Report No. 13) by Vasavithasan and Rutter, 2004. A number of statistical methods are available to test the hypothesis that the suspect observations are not outliers but the MTO study follows the Critical Value Method recommended in Section 4 of ASTM E 178. The critical value method and iterative techniques are based on two different statistical approaches. As a result, the confidence intervals yielded by these two methods differ widely depending on the number of observations (number of laboratories participating in a particular test method) and the distribution of data.

The critical value used in this study is that value of the sample criterion, which would be

1 Laboratories must also be inspected and recognised by the Canadian Council of Independent Laboratories (CCIL).
2 ASTM C670 Practice for Preparing Precision and Bias Statements for Test Methods of Construction Materials.
3 ASTM C802 Practice for Conducting an Inter-laboratory Test Program to Determine the Precision of Test Methods of Construction Materials.
4 ASTM E177 Practice for Use of Terms Precision and Bias in ASTM Test Methods.
5 ASTM E178 Practice for Dealing with Outlying Observations.

exceeded by chance with some specified probability (significance level) on the assumption that all observations in the sample come from the same normally distributed population. The critical values provided in ASTM E 178, Table 1 are limited to 147 observations, but over 200 laboratories participate in our annual Proficiency Sample Testing Program. The critical values that are being used for the MTO study were calculated at five percent significance level (Grubb's test) based on Grubbs (1969 and 1972) recommendations for identifying outliers. The Jack Knife method recommended by Manchester (1979) is used where the strict application of the critical value method tends to include results that may not stand the best chance of representing the testing performed in conformance with each of the test methods.

2. Test Results

2.1 TABLE OF TEST RESULTS

Each participant receives an individual summary of results for their laboratory. An example of a typical report is shown in Tables 1, 2, 3, and 4. Each Table of Results identifies the laboratory by number and compares the laboratory's data with the means obtained after statistical analysis of the data received from all laboratories. The identity of the laboratories is kept confidential.

Column 1 gives the test method as designated in the MTO Laboratory Testing Manual.

Columns 2 and 3 show the test data submitted by the laboratory for a pair of samples.

Columns 4 and 5 show the mean (average) test value for each sample, for all laboratories performing the test, after removal of outliers and/or invalid test data.

Columns 6 and 7 list the standardized deviate for each test result. The standardized deviate is used to show how the individual test results compare to the mean. It is obtained by subtracting the mean of all data ($\overline{X}$) from the actual test result reported by the laboratory (X_i) and dividing by the standard deviation (s). That is:

$$\text{Standardized deviate} = \frac{\left(X_i - \overline{X}\right)}{s}$$

If the test result is less than the mean, the standardized deviate is negative, and if the test result is greater than the mean, the standardized deviate is positive. In brief, the standardized deviate tells us how many standard deviations the test result is away from the mean.

Columns 8 and 9 list the test method ratings, which are similar to the standardized deviate, but are in a simple numeric form. Ratings are determined as follows:

Rating 5 - data within 1.0 standard deviation of the mean.
Rating 4 - data within 1.5 standard deviations of the mean.
Rating 3 - data within 2.0 standard deviations of the mean.
Rating 2 - data within 2.5 standard deviations of the mean.
Rating 1 - data within 3.0 standard deviations of the mean.
Rating 0 - data 3.0 or more standard deviations from the mean or data considered to be outlying by other methods.

A negative sign simply indicates a result that is smaller than the mean. If one of the paired test results for a given test is excluded based on the outlier criteria, the other test result is still subjected to the statistical analysis and is only excluded if it also fails to meet the criteria.

An outlying observation is one that appears to deviate markedly from the sample population. It may be merely an extreme manifestation of the random variability inherent in the data or may be the result of gross deviation from the prescribed experimental procedure, calculation errors or errors in reporting data. The outlier criteria employed for exclusion of test results

from the analysis will depend on the distribution of data and the number of participants in a test. The iterative technique is one of the methods employed in this study for the selection of outliers, and is used where the strict application of critical value method tends to include the data that does not belong to the population. In the critical value method, the standardized deviate of a lab result is compared with the critical value corresponding to the number of participants in that particular test for rejecting an outlier. The critical value is greater than 3 when the number of participants in a particular test method is 30 or more. For this reason, results with more than 3 standardized deviates may not have been identified as an outlier unless it is higher than the critical value, but a zero rating is nevertheless assigned for the test result in question. For example, if the computed standardized deviate for a lab result is 3.236 and the critical value corresponding to the number of participants in that particular test is 3.427, the lab will not be identified as an outlier but a zero rating will be assigned.

Significance need not necessarily be attached to a single low rating. However, a continuing tendency to get low ratings on several pairs of samples or on a series of tests from one procedure, *e.g.* sieve analysis, should lead a laboratory to re-examine its equipment and test procedure. A laboratory that reports data for a specific test consistently lower or higher than the mean over a number of test periods also needs to re-examine their test procedure, because this is evidence of a systematic bias in how the laboratory conducts the procedure. Any computer program that is used by a laboratory to calculate test results should be verified as part of this examination.

2.2 SCATTER DIAGRAMS

Youden scatter diagrams are supplied with this report (see Appendices D1 and D2). A laboratory can locate itself on the diagrams by plotting its test value for the first sample (1.06) on the horizontal axis, against its test value for the second sample (2.06) on the vertical axis. The horizontal and vertical axes are of equal length and are scaled to give the most informative display of the plotted points. In some cases, the outlying results plot outside the boundaries of the diagram. If the results from two or more laboratories happen to coincide, a single point is plotted.

Below each scatter diagram, the test number and title are given, followed by a table of statistical calculations for both samples. Here the mean, median and standard deviation for each sample are given. The number of laboratories reporting valid data and the laboratories eliminated by statistical analysis are also listed.

The vertical and horizontal cross hairs on the plots represent the mean values for all the results on the first sample (1.06) and the second sample (2.06), respectively. These lines divide the diagram into four quadrants, numbered 1 through 4, beginning in the upper right-hand quadrant and continuing clockwise. In an ideal situation where only random errors occur, the points are expected to be equally numerous in all quadrants and will form a circular distribution. This follows because plus and minus errors should be equally likely. Often, however, the points tend to concentrate in quadrants 1 and 3 on the diagram. This occurs because laboratories tend to get high or low results on both samples. This gives evidence of individual laboratory biases. As the tendency to laboratory bias increases, the

departure from the expected circular distribution of points towards a linear distribution from quadrant 1 to 3 occurs. Such a distribution of points indicates systematic variation. Figure 1 gives examples of scatter diagrams.

Table 1. Summary of Results for Laboratory 47

TEST RESULTS FOR LABORATORY NUMBER 47			DATE PREPARED: October 5, 2006					
COARSE AGGREGATE REFERENCE SAMPLES 1.06 & 2.06								
TEST METHOD	LABORATORY DATA		MEAN OF LABORATORIES		STANDARDIZED DEVIATE		LAB RATING	
	1.06	2.06	1	2	1	2	1	2
LS-601 Wash Pass 75 µm (Coarse Aggr.)	1.410	0.980	1.359	1.456	0.186	-1.665	5	-3
LS-602 – Coarse Aggregate Percent Passing 19.0 mm	94.900	95.700	95.647	95.619	-0.888	0.107	-5	5
Percent Passing 16.0 mm	87.000	88.000	88.254	88.140	-1.102	-0.161	-4	-5
Percent Passing 13.2 mm	80.700	82.000	81.479	81.346	-0.605	0.653	-5	5
Percent Passing 9.5 mm	69.800	71.200	70.533	70. 502	-0.517	0.622	-5	5
Percent Passing 4.75 mm	55.050	56.210	55.512	55.468	-0.362	0.739	-5	5
LS-603 Los Angeles Abrasion %	17.800	17.900	18.470	18.150	-0.445	-0.129	-5	-5
LS-607 Percent Crushed Particles	71.400	72.000	74.260	74.186	-0.684	-0.503	-5	-5
LS-608 % Flat & Elongated Particles	9.700	10.500	9.667	8.964	0.009	0.434	5	5
LS-609 Petrographic Number (Concrete)	122.40	121.10	122.7	120.9	-0.035	0.028	-5	5
LS-614 Freeze - Thaw Loss, %	11.500	12.200	12.684	13.222	-0.856	-0.510	-5	-5
LS-618 Micro-Deval Abrasion Loss (CA)	5.500	5.300	5.591	5.415	-0.236	-0.333	-5	-5
LS-620 Accelerated Mortar Bar (14 Days)								

Blank spaces represent not tested.
* - Calculation considered outlier

Table 2. Summary of Results for Laboratory 47

TEST RESULTS FOR LABORATORY NUMBER 47			DATE PREPARED: October 5, 2006					
FINE AGGREGATE REFERENCE SAMPLES 1.06 & 2.06								
TEST METHOD	LABORATORY DATA		MEAN OF LABORATORIES		STANDARDIZED DEVIATE		LAB RATING	
	1.06	2.06	1	2	1	2	1	2
LS-623								
Maximum Wet Density (g/cm^3)	2.282	2.273	2.271	2.272	0.340	0.035	5	5
Maximum Dry Density (g/cm^3)	2.103	2.093	2.093	2.095	0.251	-0.053	5	-5
Optimum Moisture, %	8.500	8.600	8.550	8.481	-0.101	0.195	-5	5
LS-604 – Coarse Aggregate								
Relative Density (O.D)	2.661	2.656	2.669	2.669	-1.511	-2.100	-3	-2
Absorption	1.920	1.960	1.840	1.834	0.862	1.547	5	3
LS-621								
Asphalt Coated Particles, %	43.500	41.100	39.704	39.942	0.810	0.246	5	5

Blank spaces represent not tested.
* - Calculation considered outlier

Table 3. Summary of Results for Laboratory 47

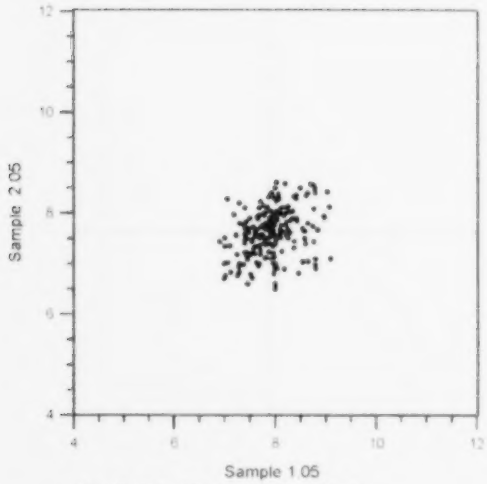
TEST RESULTS FOR LABORATORY NUMBER 47			DATE PREPARED: October 5, 2006					
FINE AGGREGATE REFERENCE SAMPLES 3.06 & 4.06								
TEST METHOD	LABORATORY DATA		MEAN OF LABORATORIES		STANDARDIZED DEVIATE		LAB RATING	
	3.06	4.06	3	4	3	4	3	4
LS-605 – Fine Aggregate								
Relative Density (O.D)	2.663	2.640	2.665	2.616	-0.146	0.623	-5	5
Absorption	0.740	1.110	0.746	1.502	-0.045	-0.802	-5	-5
LS-606 – Coarse Aggregate								
MgSO4 Soundness Loss, %	6.800	7.700	7.506	7.492	-0.313	0.101	-5	5
LS-606 – Fine Aggregate								
MgSO4 Soundness Loss, %	12.400	13.200	11.703	11.719	0.204	0.463	5	5
LS-619- Fine Aggregate								
Micro-Deval Abrasion	11.500	11.100	11.613	11.728	-0.120	-0.743	-5	-5
LS-611								
Attrition Loss (FA), %								
LS-602 – Fine Aggregate								
Percent Passing 2.36 mm	43.600	44.500	45.370	45.331	-1.045	-0.521	-4	-5
Percent Passing 1.18 mm	35.400	35.500	36.504	36.491	-0.531	-0.506	-5	-5
Percent Passing 600 µm	27.100	26.500	28.171	28.236	-0.586	-0.924	-5	-5
Percent Passing 300 µm	18.500	17.800	18.989	19.091	-0.381	-0.942	-5	-5
Percent Passing 150 µm	11.800	11.200	12.017	12.180	-0.265	-1.151	-5	-4
Percent Passing 75 µm	7.680	7.200	7.752	7.842	-0.124	-1.083	-5	-4

Blank spaces represent not tested.
* - Calculation considered outlier

Table 4. Summary of Results for Laboratory 47

TEST RESULTS FOR LABORATORY NUMBER 47			DATE PREPARED: October 5, 2006					
SOILS REFERENCE SAMPLES 1.06 & 2.06								
TEST METHOD	LABORATORY DATA		MEAN OF LABORATORIES		STANDARDIZED DEVIATE		LAB RATING	
	1.06	2.06	1	2	1	2	1	2
LS-702 – Sieve Analysis of Soil								
Percent Passing 2.00 mm	100.00	100.00	99.989	99.983	-	-		
Percent Passing 425 μm	97.000	97.300	96.960	96.945	0.071	0.696	5	5
Percent Passing 75 μm	91.500	91.900	91.729	91.533	-0.284	0.468	-5	5
Percent Passing 20 μm	68.000	69.000	78.109	78.907	-1.672	-2.191	-3	-2
Percent Passing 5 μm	**46.500**	**46.500**	**59.161**	**58.903**	**-4.583**	**-4.313**	**0**	**0**
Percent Passing 2 μm	**34.200**	**34.900**	**44.469**	**44.643**	**-3.267**	**-3.142**	**0**	**0**
LS-703								
Liquid Limit, %	38.600	38.400	37.134	36.937	0.777	0.763	5	5
LS-704								
Plastic Limit, %	20.700	20.700	19.192	19.048	0.961	1.056	5	4
Plasticity Index, %	17.900	17.600	17.936	17.982	-0.022	-0.194	-5	-5
LS-705								
Specific Gravity of Soil	2.764	2.761	2.733	2.730	1.037	1.021	4	4
AGGREGATE CONSENSUS PROPERTIES								
Uncompacted Void Content	43.500	43.000	43.132	42.059	0.539	0.869	5	5
Sand Equivalent Value	55.000	55.000	56.372	55.957	-0.238	-0.162	-5	-5
Percent Fractured Particles	73.200	71.200	75.667	76.063	-0.623	-1.034	-5	-4
% Flat & Elongated Particles	4.400	4.200	2.680	2.247	1.261	1.689	4	3

Blank spaces represent not tested.
* - Calculation considered outlier

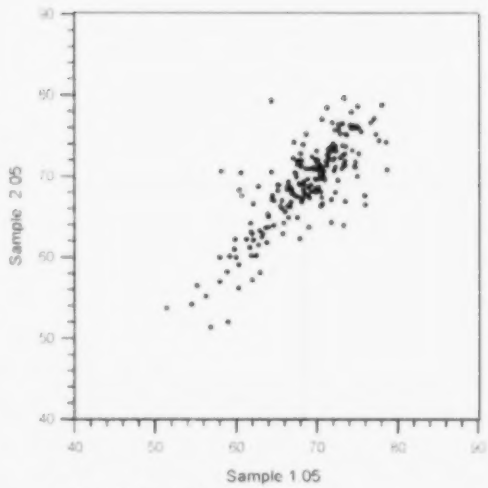


Test 25 Percent Passing the 75 um Sieve

	Mat 1	Mat 2
Mean	7.930	7.630
Median	7.800	7.500
Std Dev	0.460	0.470
n = 203		

Labs Eliminated 447 497 452 518

Scatter diagram for a test showing random variation with little laboratory bias

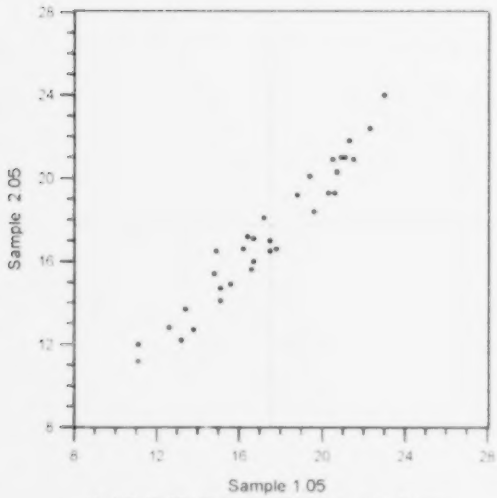


Test 12 Percent Crushed Particles

	Mat 1	Mat 2
Mean	68.491	68.905
Median	68.200	64.500
Std Dev	5.054	5.402
n = 201		

Labs Eliminated 345 350 436 480

Scatter diagram for a test showing a combination of random variation and laboratory bias for some laboratories

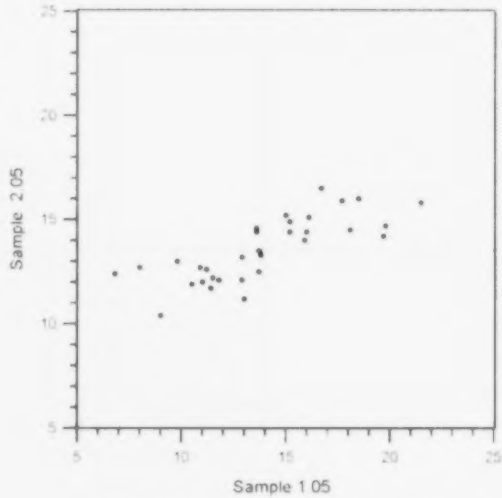


Test 29 MgSO4 Soundness (Fine Aggregate), % Loss

	Mat 1	Mat 2
Mean	17.370	17.258
Median	15.800	15.600
Std Dev	3.278	3.325
n = 32		

Lab Eliminated None

Scatter diagram for a test showing pronounced between laboratory bias and equal variation for each material



Test 11 MgSO4 Soundness (Coarse Aggregate), % Loss

	Mat 1	Mat 2
Mean	13.890	13.570
Median	12.900	13.600
Std Dev	3.533	1.541
n = 31		

Lab Eliminated None

Scatter diagram for a test with pronounced between laboratory bias but unequal variation for each material

Figure 1. Examples of Scatter Diagrams

2.3 OUTLIERS

In dealing with suspected outlying observations or 'outliers', our purpose is to remove those observations that do not belong to the sample population and to provide some statistical criteria for doing so. There are a number of ways to do this. In most of these, as ASTM E178 states, 'the doubtful observation is included in the calculation of the numerical criterion (or statistic), which is then compared with a critical value based on the theory of random sampling to determine whether the doubtful observation is to be retained or rejected. The critical value is that value of the sample criterion that would be exceeded by chance with some specified (small) probability on the assumption that all observations did indeed constitute a random sample from a common system of causes, a single parent population, distribution or universe.

The MTO study follows the criteria recommended for single samples in Section 4 of ASTM E 178 for rejecting the doubtful observations at the ninety-five percent confidence level. The critical value method is based on the assumption of normality and the critical values are calculated using Student's t distribution. The assumption in this method is that all the observations come from the same normal population. The doubtful observation is included in the calculation of mean and standard deviation of the population. Then the critical value, T_n, for that observation, n, in question is calculated and compared with the critical value based on the theory of random sampling. The doubtful observation is rejected if T_n is higher than the critical value for the five percent significance level. The outlier is removed from the data set and the iterations are continued until no outliers are detected, and a revised mean and standard deviation are calculated after deleting the outlier. The ratings of the laboratories are determined based on the revised mean, standard deviation and standardised deviate.

In some cases, the strict application of the critical value method tends to include laboratories in the population who are not doing a good job. In those cases, the application of the iterative technique (Manchester[6]) is used. In the iterative technique, the Constant C is computed using Fisher's F distribution, and C depends on the number of participating laboratories. In this technique, an outlying observation is rejected based on a statistical criterion but the confidence interval may vary depending on the number of participants and the distribution of sample population.

In the iterative technique, after screening the test results for any errors, the doubtful test result is included in the calculation of mean and standard deviation of the data set. The absolute residual values (actual test result minus the mean) are then computed and test result farthest from the mean by a unit of Cs (standard deviation (s) multiplied by a constant C) is identified as an outlier. One outlier at a time is identified and rejected in a manner similar to that of critical value method.

6 The Development of an Interlaboratory Testing Program for Construction Aggregates, by L. Manchester, Ministry of Transportation, Ontario, Engineering Materials Office Report EM-33, Downsview, December, 1979.

3. Discussion

The following discussion contains general and test-specific comments for the 2005 test period. Where ASTM or AASHTO precision statements are published for a given test, an attempt has been made to compare these with the statistics for this period.

A discussion of statistical techniques is presented in the Glossary of Terms, found in Appendix A.

3.1 NOTES ON MATERIAL SOURCES

Materials used in this test period were as follows:

- Coarse and fine aggregate tests, including Sieve Analysis, Percent Crushed Particles, Petrographic Analysis, Freeze-Thaw, Magnesium Sulphate Soundness (CA & FA), Relative Density and Absorption (FA), Moisture Density Relationship, Micro-Deval Abrasion Loss (FA), Uncompacted Void Content of Fine Aggregate, Sand Equivalent Value of Fine Aggregate, and Percent Fractured Particles - Granular 'A' from K. J. Beamish Fairgrounds Pit, City of Orillia (MTO MAIDB No. O11-011).
- Coarse Aggregate tests, including Wash Pass 75 µm, Los Angeles Abrasion, Percent Flat and Elongated Particles, Relative Density and Absorption, Micro-Deval Abrasion Loss, and Percent Flat, Elongated, or Flat and Elongated Particles - HL8 Stone from Ridgemount Quarry, Fort Erie (MTO MAIDB No. W03-007).
- Fine Aggregate Petrographic Examination - Scalped sand from the Barino Construction pit (MTO MAIDB Number L05-040) North of Longlac.
- Soil tests – Glacial Lake Iroquois deepwater laminated silt and clay from Walker Brothers Vineland I Quarry, N03-023.

3.2 NOTES ON SAMPLE PREPARATION

The material processed for the aggregate tests conforms approximately to a granular 'A' gradation. The aggregate samples were prepared using a large spinning riffler, developed and built by staff at the MTO Downsview Laboratory (refer to Figures 2 and 3 of Report MI-179, February 2000). A bobcat loader was used to fill an aggregate bin with small scoops from the stockpile and the material was fed along a conveyor belt to fill 30 identical bags (fitted with funnels) on a spinning turntable. It was found that 22 to 26 revolutions of the turntable were required to fill each bucket to approximately 30 Kg. This resulted in more homogeneity of the samples than would normally be the case using other techniques. In total, five hundred 30 Kg samples were prepared and randomised for distribution to participating laboratories. The participants were responsible for the preparation of their own fine aggregate samples (3.06 and 4.06) from the two bags of granular 'A' delivered.

The soil was air-dried, processed passing 2.0 mm using a Fritsch Soil Mill Pulverizer, and placed in 20 Kg buckets. Individual scoops were collected from each bucket and placed in a separate container. The material from the container was then transferred to the hopper of a small spinning riffle splitter. The hopper of the spinning riffle used is capable of filling 24 identical 2 Kg containers per run. This method was used to create uniform 20 Kg buckets. The correlation material was then prepared by obtaining representative samples from a 20 Kg bucket. The material collected from the 20 Kg bucket was then transferred to the hopper of the spinning riffle and the 500 g correlation samples were prepared. Then the samples were randomised for distribution to participating laboratories. The use of a spinning riffler ensured that as far as possible, each sample was identical to every other sample. It has been found that this is the best technique for minimising sample bias.

3.3 NOTES ON INDIVIDUAL TESTS

For each test, comments have been made pertaining to the variation illustrated by the scatter diagram. The technique used to test for outliers is stated and where possible, reasons for the outlying observations are offered. It is important to keep in mind that there are many variables influencing laboratory testing.

A summary of the statistical data is presented in the Multi-Laboratory Precision Tables found in the Appendix C. Besides the comparison made to ASTM precision statements, comparison of the variation between test periods is made for each of the tests. Because the materials usually differ from year to year, it is emphasised that the comparison between years should be used only as a guide. It is important to note that the yearly use of different materials will have some effect on the variation exhibited in some tests, while it will have relatively little effect on others. For example, the magnesium sulphate soundness test normally exhibits increased variation as higher mean loss is reported. A coarse aggregate sample having an average mean loss of twenty percent would likely show more variation than a coarse aggregate sample having an average mean loss of ten percent. On the other hand, a sieve analysis could be performed on those same two aggregates, with the percent passing each sieve and the variation being remarkably similar for the two samples.

3.4 PROFICIENCY SAMPLE TESTS

3.4.1 Wash Pass 75 μm (Coarse Aggregate) – Test No. 1

Two hundred and eight laboratories participated in this test in 2006. Eight outliers were identified and rejected using the critical value method. The standard deviation is consistent with the values obtained in 2005, and is similar to the multi-laboratory variation published by ASTM for aggregates with less than 1.5% material finer than 75μm. The scatter diagram shows a random variation with laboratory bias for some laboratories. The laboratories that are identified as outliers or with a zero rating should examine their test procedure more closely and especially the achievement of constant dry mass at the beginning and end of the test.

3.4.2 Sieve Analysis (Coarse Aggregate) – Test Nos. 2-6

These tests represent the coarse aggregate portion of the sample gradation. Tests 20-25 carried out on the material passing 4.75 mm sieve as prepared by the participants (samples 3.06 and 4.06), represent the remainder of the gradation. The data is presented in percent passing format and is compared to precision statements developed in the same format by Vogler and Spellenberg[7].

The samples were prepared with a large spinning riffler that is described in Section 3.2. This method of preparation minimises the sample variation and has resulted in no observable average gradation difference between samples 1.06 and 2.06. The variations found in 2006 for the coarse sieves are consistent with that of the values obtained in 2003 and 2005. In addition, the standard deviations, except for 19.0 mm sieve, are significantly lower than that of the values obtained in 2004, and the expected variations given in the ASTM precision statements.

Two hundred and eight laboratories performed the sieve analysis test in 2006. Outliers were eliminated using the critical value method. Successive scatter diagrams show a fairly uniform distribution of points about the mean. The number of outliers identified varies from sieve to sieve, and it ranges from none for 19.0 mm sieve to a maximum of eight for the 16.0 mm sieve.

Possible reasons for outlying observations include factors that impact the measurement process such as sieve condition (state of repair and cleanliness), efficiency of the sieving process and apparatus, initial sample mass, and mass on a given sieve. If your laboratory has performed poorly in this test period, you should inspect your sieves (use CAN/CGSB-8.1-88 or ASTM E-11 as guides) and your sieve shaker(s) thoroughly, and once satisfied that they are in order, perform a sieving efficiency test (MTO Method LS-602, Revision No. 23) to pinpoint any problems.

3.4.3 Los Angeles Abrasion Loss (Coarse Aggregate) – Test No. 8

Only ten laboratories participated in this test. No outlier was detected by the use of critical value method or iterative technique. Considering the number of observations (10) used, the analysis may not yield a meaningful or representative statistical data. The lower left and upper right quadrants together account for all of the ten points, which is evidence of significant laboratory biases. This test shows systematic variation, as was found in previous years, and the variations in 2006 are slightly higher than that of the values found in the past studies. The variation observed is far too wide to occur due to random chance. Laboratories, which reported either low or high values, should critically examine their equipment and techniques.

ASTM precision statements for 19.0 mm maximum size coarse aggregate, with percent loss

7 Vogler, R.H., Department of Transportation, Michigan, AASHTO Technical Section 1c; T27 and Spellenberg, P.A., AASHTO Materials Reference Laboratory; Unpublished Paper.

in the range 10 to 45%, give a multi-laboratory coefficient of variation of 4.5%. Therefore, results from two different laboratories should not differ by more than 12.7%. The mean in this test (18.3%) is in the range of values for which ASTM data was established. This year's coefficient of variation (average 9.4%) is twice that of the value given in the ASTM precision statements.

A review of the AASHTO proficiency sample test results was undertaken to examine whether the precision estimate published by ASTM is too low. The multi-laboratory coefficient of variation published by the AASHTO Materials Reference Laboratory for four pairs of coarse aggregate samples range from 5.4% to 7.9%, with an average value of 6.4%. The mean abrasion losses reported for those samples tested range from 13.6% to 42.9%, which is similar to the range of mean losses published in the ASTM precision statements. The statistical results reported by the AASHTO proficiency sample testing program from 1981 to 2000, also indicate that the variations obtained for this test over twenty years period were consistent and the coefficient of variation varied between 4.7% and 9.5%, with an average value of 6.6%. The multi-laboratory precisions reported by the AASHTO proficiency program indicate that there is a need for improvement in the performance of the laboratories participating in this test.

3.4.4 Relative Density (Coarse Aggregate) - Test No. 9 and Absorption (Coarse Aggregate) – Test No. 10

One hundred and one laboratories participated in these tests in 2006. Ten laboratories in Test No. 9 and nine laboratories in Test No. 10 were eliminated using the iterative technique. The standard deviations obtained for bulk relative density (Test No. 9) are consistent with that of the values found in the past three years, and are considerably less than the values given in the ASTM precision statements. A similar trend was observed in the absorption test (Test No. 10). The variation obtained in 2006 is similar to that of the values reported in 2003 and 2004, and are almost one-half of the values reported in 2005 and that of the estimate provided in ASTM precision statements. The latest version of ASTM C 127 - 04 does not provide precision estimate for the absorption test. The expected variation shown on the precision table in Appendix C is based on the previous publication C 127 - 88. The scatter diagrams for both of these tests show a combination of random variation and laboratory bias for some laboratories.

3.4.5 Magnesium Sulphate Soundness (Coarse Aggregate) – Test No. 11

Thirty-seven laboratories performed this test in 2006. Only one outlier was identified by the use of both, critical value method and iterative technique. The scatter diagram shows a strong laboratory bias and all the points, with the exception of five, are accounted in the lower left and upper right quadrants. This test has historically shown high coefficients of variation due to the difficulty of maintaining solution of the correct density and insufficient drying by some laboratories. The coefficient of variations obtained in 2006 (28.6%) is slightly higher than the value reported in 2005 (24.9%), but is noticeably lower than that of the value reported in 2004 (34.9%). The variation is also slightly higher than the value published in ASTM precision statements, which report an expected coefficient of variation of 25% for the percent loss range of 9 to 20.

3.4.6 Percent Crushed Particles – Test No. 12 and Percent Cemented Particles – Test No. 7

Two hundred and eight laboratories performed the percent crushed particles test in 2006. Twelve outliers were selected by employing the critical value method. Variation (4.2%) is noticeably lower than the value (6.0%) obtained during 1989 MTO workshop. The mean in this test (74.2%) is within the range of values (50% to 75%) for which the MTO precision statement was established. The variation in 2006 is also slightly lower than the values obtained in the past three years. The scatter diagram shows a random variation with noticeable laboratory operator bias. The samples distributed did not contain any cemented particles; therefore the percent cemented particles test was not evaluated this year. ASTM has a very similar test method (D 5821) but has not conducted inter-laboratory studies to determine precision and currently publishes precision data (standard deviation of 5.2% for a mean value of 76.0%) obtained from MTO.

3.4.7 Percent Flat and Elongated Particles – Test No. 13

The determination of a flat and/or elongated particle is dependent on operator skill and judgement in using the measurement tool. The ASTM and CSA procedures use a proportional calliper device to measure the *greatest* length or width to thickness ratio. The MTO procedure previously measured the *mean* length or width to the *mean* thickness (MTO Laboratory Manual Revision 15 and earlier). The MTO procedure (Revision 16 and up) has been modified to agree with the ASTM definition. All participants should be using the latest MTO version of the test.

One hundred and sixty nine laboratories reported results for this test in 2006. The critical value method was used to reject six outliers. ASTM and CSA do not report precision for this test method. However, a review of the test data (Vasavithasan and Rogers, 2007) gathered from the MTO studies conducted since 1989 indicate that the standard deviation increases with the increase in the mean per cent flat and elongated particles. Further, the review suggests that the multi-laboratory standard deviation (S) may be expressed as a function of the percent flat and elongated particles (P_f) by the equation, $S = 0.95 + 0.3\ (P_f)$. The graph from the publication is included in Figure 2 to show the precision obtained in 2006 in relation to the mean and standard deviations obtained since 1989. The multi-laboratory standard deviation of 3.5 obtained in 2006 for the mean percent flat and elongated particles value of 9.3% is consistent with the standard deviation of 3.7 computed by the above empirical equation. However, the majority of the points in the scatter diagram are accounted in the lower left and upper right quadrants indicating pronounced between laboratory operator biases and almost equal variation for each sample. In general, laboratories that reported values in excess of 15% or less than 4.5% should critically examine their equipment and procedure.

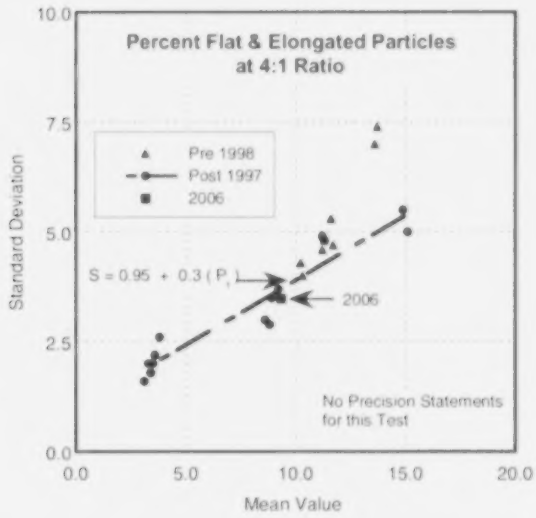


Figure 2. Multi-Laboratory Variation of Percent Flat and Elongated Particles Test

3.4.8 Petrographic Number (Concrete) – Test No. 14

The coarse aggregate examined in 2006 was Granular 'A' from K. J. Beamish Fairgrounds Pit, City of Orillia (MTO MAIDB No. O11-011).

Analysts from twenty-five laboratories examined samples 1.06 and 2.06 (full fraction), and submitted work sheets showing subdivision according to rock type and quality. Laboratories 59, 101, and 203 used the same analyst, as did 13 and 80.

In this test period the coarse aggregate was a partly crushed gravel containing carbonate rocks from the Bobcaygeon and Gull River Formations with small amounts of granite and gneiss from the Precambrian terrain outcropping about 15 km to the north. Some observers found small to moderate (9%) amounts of chert bearing carbonate (type 21), which is characteristic of some rocks of the Bobcaygeon formation. Others did not recognize this component. The amount of 'good quality' carbonate averaged 82% with a range for experienced observers from 77 to 85%. However there was disagreement about the proportions assigned to the various Types within the good category. Some recognized significant amounts of surfaced weathered/medium hard category (Type 20), finding up to about 45%, others found far lower amounts.

There were also moderate amounts of siliceous rocks falling mainly into the gneiss (Type 04) and granite category (Type 08). Most of this fell into the good group with smaller amounts in the fair and very occasionally in the poor category. Rarely trace amounts of quartzite or sandstone was found.

In the Fair group, small amounts of soft or slightly shaley carbonate were found ranging from 1.5% to about 10% with an average for experienced observers of about 3.5%. Many

observed trace amounts of cherty carbonate (Type 26) in the order of about 1%.

In the Poor group, small amounts of shaley carbonate, cementations (total or partial) and friable gneiss or granite were reported.

The only Deleterious group rock type found was trace amounts of clay.

Last year petrographic performance was either classed as acceptable or unacceptable. This was because of the failure of some to correctly identify the rock types present. In this year's correlation, nearly everyone correctly classified the rock types present. There was discrepancy between observers about the relative proportion of various fair and poor quality rock types. Under these circumstances it is judged satisfactory to use the scatter diagram technique and a numerical rating system. Those operators who reported either a relatively high or low Petrographic Number and received a correspondingly low numerical rating (4 or less) should critically re-examine their samples and try and determine in which way they may be too severe or too lax in determining quality of the rock types present.

The similar ASTM standard for this test, C-295, does not report a petrographic number and has no precision statement.

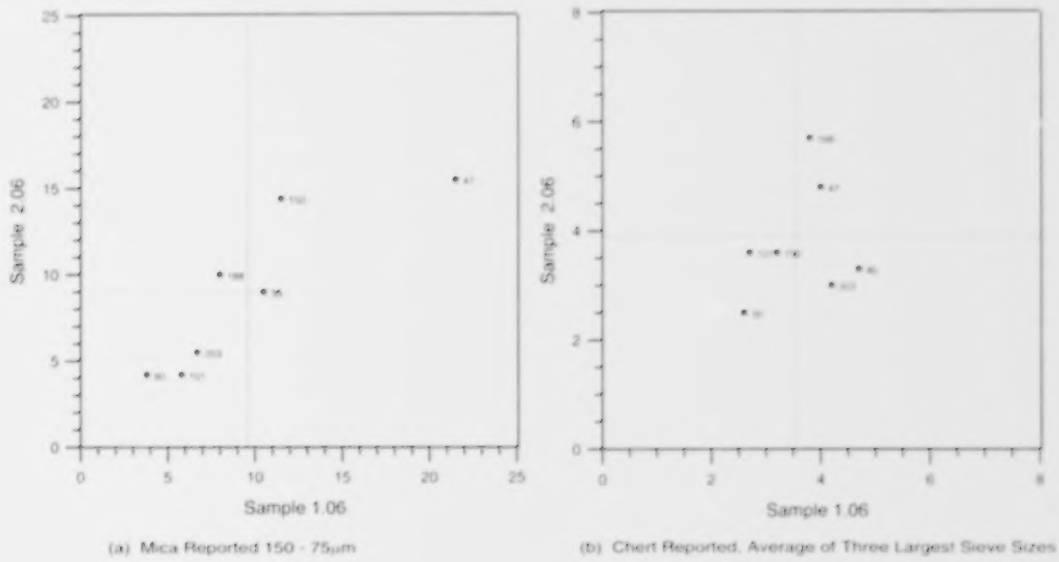
3.4.9 Petrographic Analysis (Fine Aggregate)

The fine aggregate examined in 2006 was sand from the Barino Construction pit (MTO MAIDB Number L05-040) North of Longlac.

Analysts from seven laboratories examined samples 1.06 and 2.06, and submitted work sheets showing subdivision according to rock/mineral type and sieve size. Laboratories 80, 101 and 203 used the same analyst. The material this year was from the Longlac area of northern Ontario and was natural sand with a mixture of carbonate and silicate rocks. There were small amounts of chert (typically leached and lightweight).

All operators recognized the main components. There were some differences in measured proportions of rock types in the samples. Examples of these are shown in two scatter diagrams. One shows the mica content, which is the amount, reported on the minus 150µm retained 75µm fraction. The other scatter diagram shows the chert content, which is the average of the three largest sieve sizes examined (600µm and up). The three smaller sieves contained either no or negligible amounts of chert.

The similar ASTM standard for this test, C-295, has no precision statement.



(a) Mica Reported 150 - 75μm (b) Chert Reported, Average of Three Largest Sieve Sizes

Figure 3. Fine Aggregate Petrographic Examination Scatter Diagrams

3.4.10 Micro-Deval Abrasion (Coarse Aggregate) – Test No. 16

Sixty-one laboratories reported results for this test in 2006. The test method requires reporting of control sample results to demonstrate that the testing process is in control. This year, one laboratory reported control sample results outside the established range and the lab was excluded from the analysis. Two outliers were rejected using the iterative technique. The test method (LS-618) for coarse aggregate with a MDA value of 5.0 gives a multi-laboratory coefficient of variation of 10.0%. The mean loss in this test was 5.5, and the coefficient of variation of 6.6% obtained in 2006 is noticeably lower than the value published in LS-618. Further, the standard deviations obtained for both samples are considerably lower than that of the values reported in the past three years. The scatter plot for this test shows a combination of random variation and laboratory bias for some laboratories.

3.4.11 Freeze-Thaw Loss – Test No. 17

Forty-eight laboratories reported results for this test in 2006. The test method requires reporting of laboratory control sample losses to demonstrate that the testing process is in control. This information is used to alert the laboratory to testing deficiencies. Without testing of the reference material, the test is invalid (see LS-614, section 9.1). This year, all the participants have reported control sample results within the established range. Four outliers were selected using the iterative technique. The standard deviations (1.38 and 2.00) obtained for both samples, are significantly lower than the multi-laboratory precision statements published in LS-614, and the coefficient of variation in 2006 (13.1%) is considerably lower than the range of values (20.0% to 21.3%) reported in 2003 to 2005 studies. The scatter diagram shows a combination of random variation and laboratory bias

for some laboratories, which is an improvement in the performance of the laboratories compared to the past. The results reported by the outlier laboratories deviate considerably from the mean values. It is likely that there are two main reasons for the wide spread of their data: insufficient damage caused by freezing which may be due to freezing too rapidly or difference in sieving intensity. The laboratories identified as outliers should modify their processes to try and achieve losses closer to the mean loss of the control aggregate. LS-614, Revision 22 (Appendix 1) in the MTO Laboratory Testing Manual gives a procedure for determining and adjusting sieving time for quantitative analysis. It is possible that increased use of this procedure to adjust sieving time is having a positive effect on performance of laboratories in this test.

3.4.12 Sieve Analysis (Fine Aggregate) – Test No. 20-25

The samples for this procedure were prepared by the participants from the material passing the 4.75 mm sieve of the coarse aggregate gradation. This process closely follows the normal testing procedure in which the laboratory prepares its own test samples from the field sample. The scatter diagrams for the fine aggregate sieve analysis show random variation with little laboratory bias. The standard deviations of the fine sieves in 2006, with the exception of Test No. 22 and 23, are consistent with that of the values reported in the past studies from 2003 to 2005. However, the multi-laboratory variations are slightly higher than the values published in ASTM. As in previous inter-laboratory studies, it was found that the precision of the test varies as a function of the amount of material retained on any sieve. The smaller the amount of material retained on the sieve, the more efficient the sieving process, and the better the precision. When there is a small amount of material on a sieve (one layer of particles or less), the particles have a greater chance of falling through the sieve in a given time.

Altogether, four outlier laboratories were selected using the critical value method. Outlier labs with a very low percent passing the 75 µm sieve should inspect their sieves, as low percent passing may be the result of the sieve being blinded when washing the sample. An ineffective washing process will also result in a low percent passing the sieve.

3.4.13 Relative Density (Fine Aggregate) – Test No. 27 and Absorption (Fine Aggregate) – Test No. 28

One hundred laboratories performed these tests in 2006. The ministry has been using the Test Method MTO LS-605 for the determination of bulk relative density and absorption of fine aggregates throughout its correlation studies. MTO LS-605 follows the ASTM C-128, except that it requires the removal of materials finer than 75 µm from the test specimen. The participants in the 2006 program were asked to test Sample 1.06 according to MTO LS-605 and Sample 2.06 in accordance with the procedures described in ASTM C 128. The significant difference between the methods is that Test Method LS-605 requires the test specimens to be prepared in duplicates and washed on the 75 µm sieve until all the material finer than 75 µm is removed. As a consequence, the tests results reported were obtained for the same materials with the only difference being the presence or absence of fines passing the 75 µm sieve. The presence or absence of material finer than 75 µm in the test specimens impacted the multi-laboratory variations obtained for both tests. The standard deviation

obtained for the bulk relative density of Sample 2.06 (ASTM Procedure) was 2.5 times that of the Sample 1.06 (MTO Procedure), and in the case of absorption test, the standard deviation of Sample 2.06 (ASTM Procedure) was 3.7 times that of Sample 1.06 (MTO Procedure).

It can be seen that testing fine aggregate with the approximately 15% fines present results in a lower relative density by 0.05 and a higher absorption of 1.1%. This is almost certainly incorrect. Values obtained when the fines are removed, based on our knowledge of minerals and rocks present, are judged to be closer to reality. MTO has modified LS-605 (Revision No. 23) so that for Superpave mix design purposes, LS-605 will be used. This will require washing of the fine aggregate prior to testing in contrast to the requirements of AASHTO T 84 and ASTM C 128.

Ten outliers for Test No. 27 and twelve outliers for Test No. 28 were selected using the iterative technique. It is imperative that differential drying of the various sized particles be avoided by *constant* stirring of the sample under the air current during the drying process. As short as 30 seconds periods of rest can be detrimental for the outcome of the test results. Differential drying of the particles is known to cause premature collapse in the cone test used to judge the saturated surface dry state. The resulting test observations are lower relative densities and higher absorption values.

The standard deviation obtained for the relative density of Sample 1.06 is consistent with the 2004 and 2005 results and is slightly higher than that of the values reported in 2003, but the multi-laboratory variation is noticeably less than the variation stated in ASTM C128. However, the standard deviation (0.038) obtained for Sample 2.06 where the ASTM procedure was followed, is significantly higher than the value (0.023) provided in the ASTM precision statements.

3.4.14 Magnesium Sulphate Soundness (Fine Aggregate) – Test No. 29

Thirty-one laboratories participated in this test in 2006. No outlier was detected by the use of iterative technique or critical value method. All the data, with the exception of four, are accounted in the lower left (quadrant 3) and upper right (quadrant 1) with the axis of scatter of points at approximately 45 degrees. As in previous years, the scatter diagram shows strong laboratory bias. The average mean of this test in 2006 was 11.7%, which is in the range of mean losses reported in 2003 and 2004. The coefficient of variation obtained in 2006 (28%) is lower than that of the values reported in 2003 (32%) and 2004 (38%). However, it is slightly higher than that of the value (22%) obtained in 2005. The ASTM precision statements are for coarse aggregates only, and there is no established estimate for fine aggregates.

3.4.15 Amount of Asphalt Coated Particles in Coarse Aggregate – Test No. 30

Two hundred and seven laboratories reported results in 2006. One laboratory was identified as an outlier using the critical value method. The scatter plot shows a combination of random variation and laboratory bias for some laboratories. The variation in 2006 is noticeably higher than the values reported in 2005, but consistent with the values obtained in

2003 and 2004. There is no comparable or similar ASTM test procedure, and no precision statement has been established by MTO. Laboratories, which reported values of less than about 31% and above 49%, should critically evaluate their interpretation of the definition and re-examine their samples.

3.4.16 Moisture-Density Relationship (One-Point Method) – Test Nos. 31-33

One hundred and fifty-one laboratories reported results for this test. Four outliers for Tests No.31 and No.33, and two outliers for Test No. 32 were rejected using the critical value method. The variations in 2006 are consistent with that of the values reported in the previous three years. The majority of the points in the scatter diagrams are located in the lower left and upper right quadrant of the plots with strong laboratory bias showing testing rather than the material variability is the source of the errors. The possible causes for the bias may be operator error and the use of an improper mould even though the participants were requested to use only the 152.4 mm diameter mould. This test also requires significant operator skill to obtain the point within the band in the first attempt. Those laboratories with poor ratings should examine their equipment and procedure to discover the causes for this variation. There is no ASTM precision statement for this test.

3.4.17 Micro-Deval Abrasion (Fine Aggregate) – Test No. 34

Participants were asked to prepare their own test sample from the bulk sample provided. Sixty-two laboratories participated in this test in 2006. The test method requires reporting of control sample test results to demonstrate that the testing process is in control. This year, all the laboratories, except one, reported control sample results within the range established for the material. Ninety four percent of the data points are located in the lower left and upper right quadrant of the scatter diagram indicating a strong laboratory bias. Only one outlier was selected by the use of both critical value method and iterative technique. The standard deviation (0.8) and the coefficient of variation (7%) obtained in 2006 are slightly higher than the multi-laboratory coefficient of variation (6.0%) published in the test method (LS-619) for a mean value of 10.5% loss. However, the coefficient of variation (7%) in 2006 is consistent with the range of values (7% to 9%) obtained in the past three years.

3.4.18 Particle Size Analysis of Soil – Test Nos. 40-45

Sixty-eight laboratories reported results for the hydrometer test in 2006. Test 40 is reported for information purposes only, because 84% of the participants reported 100% passing 2.00 mm. Outliers were selected using the iterative technique. Participants were requested to perform the test according to MTO LS-702, Revision No.19. To verify that the test procedures were followed, the laboratories were asked to submit the data sheets. Based on the information provided by the participants, three laboratories did not perform the test in accordance with MTO LS-702, and their results were excluded from the analysis.

The scatter diagrams show significant laboratory biases, especially in the case of percent passing 5μm and 2μm sizes. The standard deviations obtained in 2006 for all of the hydrometer tests (No. 40 to 45), with the exception of Test No. 43 (20μm), are consistent

with the values reported in the 2003 to 2005 studies. The standard deviations obtained for 20μm size are significantly higher than that of the values reported in the past three years. It should be noted that the soil from the same source (Walker Brothers Vineland Quarry) was used in the 2004 and 2006 correlation programs and as a result, the mean values from both years are identical to each other. However, the standard deviations obtained for 20μm and 5μm differ by a wide margin.

The laboratories that are identified as outliers should examine their equipment and procedure very carefully to make certain all is within specification and the procedure is followed exactly.

3.4.19 Atterberg Limits of Soil – Test Nos. 46-48

Seventy-eight laboratories reported results for Atterberg Limit tests in 2006. Altogether four outlier laboratories were identified using the iterative technique. The scatter plots for both liquid and plastic limits show strong laboratory bias. This variation is characteristic of tests that require significant operator skills, and good condition and calibration of the apparatus. Close attention to the condition and calibration of the liquid limit apparatus and employing skilled technicians may reduce the laboratory biases.

The variations obtained for all three tests in 2006, i.e., liquid limit, plastic limit, and plasticity index are almost similar to the values reported in 2004 and 2005 studies. The standard deviations obtained are slightly higher than the values published in ASTM. As previously noted under the hydrometer test, soil from the same source was tested in 2004 and 2006. The mean values for both limit tests, and plasticity index are almost identical, and the variations obtained are similar.

3.4.20 Specific Gravity of Soils – Test No. 49

Fifty-six laboratories reported results for this test. The participants were requested to perform the test on a minimum of three specimens in accordance with the procedures described in Section 7.1of MTO LS-705, Revision No. 20. The laboratories were asked to submit the data sheet to verify if the range, i.e., the difference between the largest and smallest value, is within the limit specified (0.02) in the test method. Based on the data sheets, one laboratory exceeded the limit and was excluded from the analysis. Three outliers were also detected using the iterative technique. Eighty-nine percent of the plots are located in 1st and 3rd quadrants of the scatter diagram showing a strong laboratory bias. Several steps in this test procedure can influence the results. Particularly, the equipment and method employed for preparation of test specimen as well as for removal of air entrapped in the pycnometer or flask. The possible cause for the bias may be because the laboratories do not fully comply with the test procedures. Laboratories finding themselves in this situation should examine their equipment and procedure very carefully.

The test method MTO LS-705 is similar to that of AASHTO T 100, which reports a multi-laboratory standard deviation of 0.04. The standard deviations obtained in 2006 are consistent with the values that were obtained in 2004 and 2005, and are considerably lower

than the value published in AASHTO T 100. As for the hydrometer and Atterberg limit tests, the results (mean and standard deviations) obtained in 2006 are very close to those of 2004 where the same material was tested.

3.5 SUPERPAVE CONSENSUS PROPERTY TESTS

3.5.1 Uncompacted Void Content (FA) – Test No. 95

Since the introduction of Superpave Consensus Property Testing Program in 2002, the participants were advised to determine the uncompacted void content of fine aggregate in accordance with Test Method A of ASTM C 1252. In 2006, the participants were asked to perform the test in accordance with the Test Method MTO LS-629, using the fine aggregate prepared by splitting the material passing 4.75 mm sieve. This test method is a modified version of AASHTO T 304 and was developed for the purposes of determining compliance with Superpave consensus properties. MTO LS-629 follows the Method A of AASHTO T 304, except for the preparation of test specimen to be used in the determination of bulk specific gravity of fine aggregates. The significant difference between the methods is that Test Method LS-629 requires the test specimens be washed on the 75 µm sieve until all the material finer than 75 µm is removed and the bulk relative density determined using the graded sample, and it does not recommend the use of the individual size fraction method described in Clause 9.4 of T 304. The participants in 2006 were also advised to compute the uncompacted void contents of Sample 1.06 and 2.06 using the bulk relative densities reported for Test No. 27, i.e., determined according to MTO LS-605 and ASTM C 128, respectively. As explained in Section 3.4.13 of this report, MTO LS-605 follows ASTM C 128, except it requires the removal of materials finer than 75 µm from the test specimens.

Fifty-five laboratories submitted results for this test in 2006. Five laboratories were identified as outliers using the iterative technique. The scatter diagram shows a combination of random variation and laboratory bias for some laboratories. The mean uncompacted void contents of the materials used since 2003 range from 41.6% to 43.1%, but the standard deviation obtained for Sample 1.06 (0.68) in 2006 is almost 0.5 times that of the values obtained in the past three year's studies. The standard deviation obtained for Sample 2.06 (1.08) is also significantly lower than that of the values reported in the past three years, however, it is 1.6 times that of Sample 1.06. The standard deviations obtained for both samples are significantly higher than the values published in ASTM for graded standard sand (0.33%). The estimates of precision in ASTM are based on graded sand as described in ASTM C 778, which is considered rounded and is graded from 600 µm to 150 µm, and may not be typical of the samples that were supplied for this testing program. The finer portion (passing 4.75 mm sieve) of the aggregate samples that we have been using for the proficiency program are similar to that of manufactured fine aggregate for which ASTM reports a standard deviation of 1.1%. The standard deviations obtained in 2006 (0.68 and 1.08) are noticeably lower than the values published for manufactured fine aggregate, i.e., Test Method C - As Received Grading. The bulk dry relative density values used for the computation of void content of Sample 1.06 range from 2.631 to 2.719 (differ by 0.088), but for Sample 2.06 (2.546 to 2.685) the densities show a greater range (0.139). ASTM C 1252

suggests that a difference in relative density of 0.05 will change the calculated void content by about one percent. The higher standard deviation obtained for Sample 2.06 may have resulted from the wide range of bulk relative density values used in the calculation of void contents. Poor performance in this test by many labs is probably due to lack of familiarity with the test procedure that was recently introduced by most of the participants in their laboratories. The wide variation in bulk density used in the calculation is also a significant source of error, especially in the case of Sample 2.06. There is marked improvement in the results of Sample 1.06, and it is hoped that improvements made to MTO LS-605 will result in improvement in the multi-laboratory variation of this test.

It should be noted that adopting the revised procedure where the fine aggregate is washed before determining density will give higher bulk relative density. This in turn will result in higher uncompacted void contents for fine aggregates with significant minus 75 µm fines contents. The impact on fine aggregates with low fines contents will be minimal since density will not change significantly.

3.5.2 Sand Equivalent Value of Fine Aggregate – Test No. 96

The participants were asked to prepare the fine aggregate sample for this test by splitting the material passing 4.75 mm sieve. Two alternate procedures for the preparation of test specimen (air-dry or pre-wet) are allowed in both ASTM and AASHTO Methods. The participants were given the option of preparing the test specimen in accordance with either method.

Fifty-three laboratories participated in this test in 2006. No outlier was identified by the use of critical value method or iterative technique. The lower left and upper right quadrants of the scatter diagram together account for 90% of the points showing significant laboratory bias. The standard deviations obtained in 2006 (5.7 and 5.9) are significantly higher than the values reported in 2005 (3.7 and 2.8). However, it is considerably lower than the multi-laboratory precision value (8.0) published by ASTM for samples with sand equivalent value less than 80.

3.5.3 Percent of Fractured Particles in Coarse Aggregate – Test No. 97

The samples supplied did not contain adequate material retained on 19.0 mm sieve. Because of this, the participants were advised to perform the test on coarse aggregate passing the 19.0 mm sieve only.

Fifty-seven laboratories submitted results for this test in 2006. Three outliers were detected using the iterative technique. The scatter diagram shows a strong laboratory bias. The average mean values obtained by both, ASTM (75.9%) and MTO (74.3%) versions of the test on the same aggregate differ by 1.6%, but an average standard deviation value of 4.3% was obtained by both of these test methods. The ASTM test method is very similar to MTO LS-607, but ASTM has not conducted inter-laboratory studies to determine precision and currently publishes statistical data provided by MTO. The variation in 2006 (4.3%) is lower than the value (5.2%) published in ASTM.

3.5.4 Percent Flat and Elongated Particles in Coarse Aggregate – Test No. 99

The samples supplied did not contain adequate material retained on 19.0 mm sieve. Because of this, the participants were advised to perform the test on coarse aggregate passing the 19.0 mm sieve only using a ratio of 5:1.

Fifty-six laboratories performed this test in 2006. One outlier was detected using the iterative technique. The standard deviations obtained in 2006 are significantly higher than that of the values reported in the past three years of studies. There is no ASTM precision statement for this test.

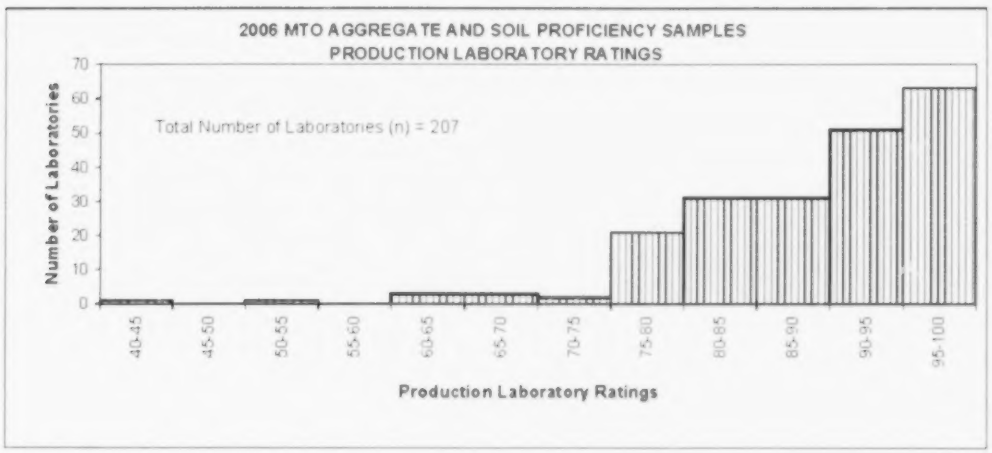
4. Laboratory Rating System

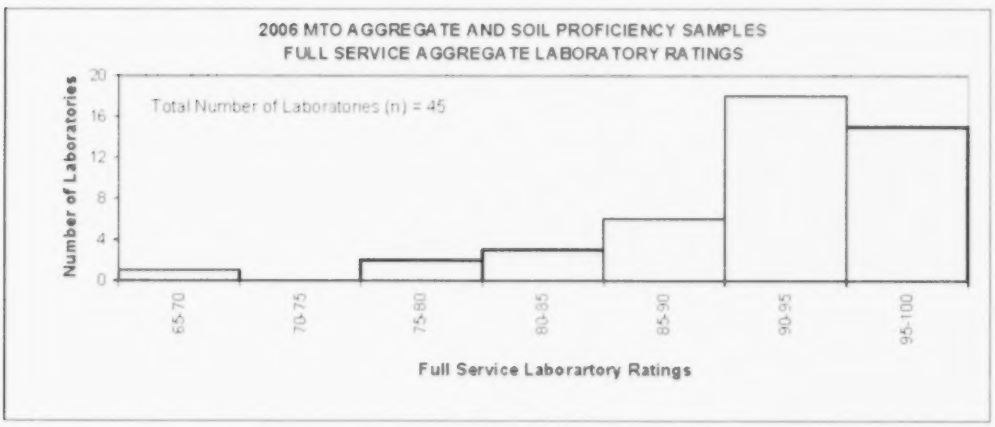
The laboratory rating system assigns separate ratings for low complexity (production) aggregate laboratories, high complexity (full service) aggregate laboratories, and for soil laboratories. Low complexity laboratories are required to carry out wash pass 75 μm, gradation, percent crushed particles, percent asphalt coated particles, and optional, percent flat and elongated particles. In addition to those low complexity tests, high complexity laboratories must carry out micro-Deval (coarse and fine), freeze-thaw and/or magnesium sulphate soundness, relative density and absorption (coarse & fine). Forty-five (45) high complexity (full service) aggregate laboratories participated in the program in 2006. Soil laboratories are required to carry out particle size analysis, Atterberg limits and specific gravity of soil. Fifty-four (54) laboratories participated in all the soil tests, in 2006.

A similar laboratory rating system is also used for assigning laboratory ratings for Superpave aggregate laboratories. The laboratories are required to perform all four tests, i.e., uncompacted void content of fine aggregate, sand equivalent value of fine aggregate, percent fractured particles in coarse aggregate, and flat and elongated particles in coarse aggregate. Fifty-three of the fifty-seven laboratories reported results for all the four consensus property tests.

The rating system gives a maximum of 10 for each test, *e.g.* 5 for wash pass 75 μm on sample 1.06, plus -5 for wash pass 75 μm on sample 2.06, equals 10 (the negative sign indicating a test result less than the mean is ignored). Some tests that are normally reported together are averaged and given a maximum of 10. The relative density and absorption (coarse and fine), one-point Proctor values (maximum wet and dry density, and optimum moisture content), particle size analysis of soils and Atterberg limits are treated in this manner. Because of the large number of individual test ratings in the gradation results, the ratings are modified so as not to unduly bias the overall balance between various tests. The ratings for each sieve size are added and then divided by the number of sieves for which results were reported, and multiplied by 3 to give a laboratory rating with a maximum of 30 for this test. Aggregate, soil, and Superpave laboratory ratings are given in Figures 4 and 5. The laboratory rating system data is reported in the Appendices E1, E2, E3, and E4.

Laboratory ratings are given in the covering letter accompanying this report to individual laboratories. A poor or good rating for a laboratory in one year is an indication of how that laboratory performed in the proficiency study, and may not be a reflection of how the laboratory performs year round. A consistently poor rating over two or more years may be cause for serious concern.





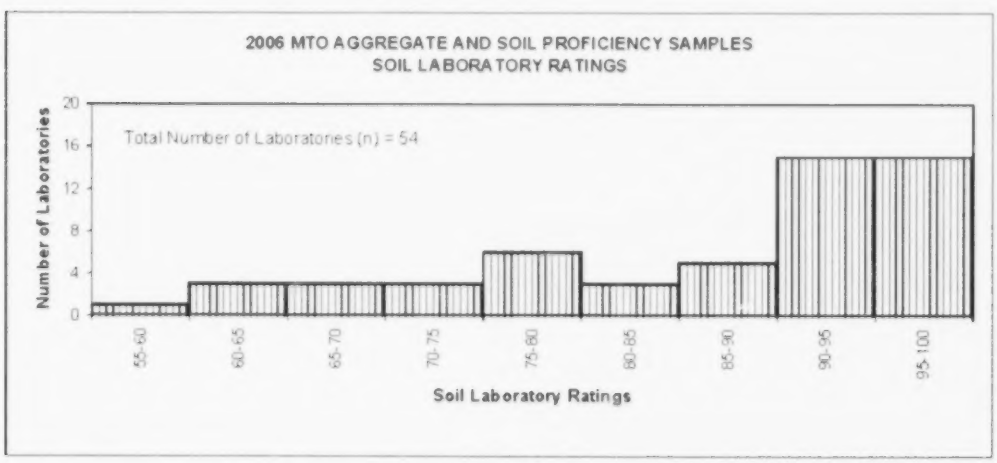


Figure 4. Laboratory Ratings

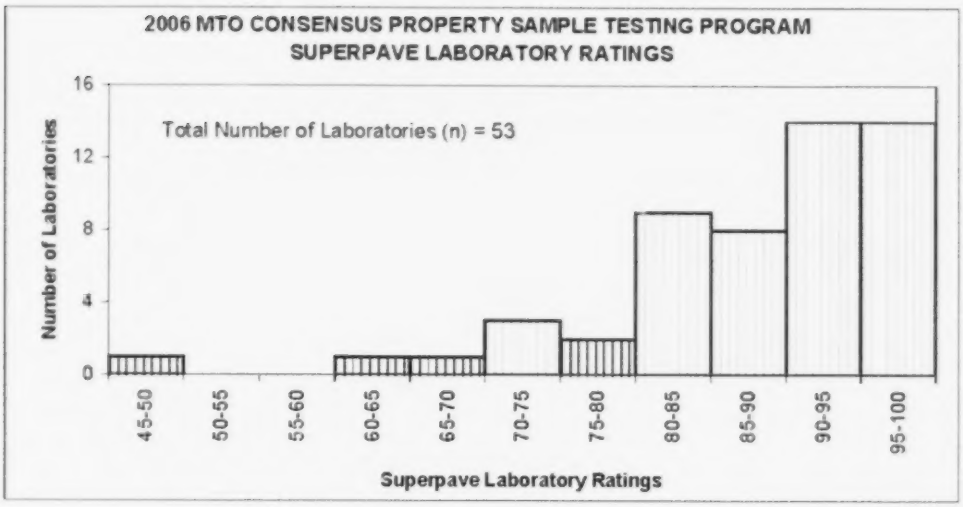


Figure 5. Superpave Laboratory Ratings

5. Conclusions

The method of proficiency sample preparation employed by MTO resulted in no significant (coarse and fine aggregate) mean gradation differences between samples 1.06 and 2.06. The differences in mean as well as in variations between pairs of samples for both, coarse and fine sieves, are negligible. Based on the results, it may be concluded that the sample preparation method employed is very effective and capable of producing a uniform material at reasonable cost.

The majority of the aggregate and soil test results of the 2006 Proficiency Sample Testing Program compare favourably but also in some cases show noticeable improvement over previous year's results. The variations in most of the tests are more or less similar to the values reported in the last four years. The scatter diagrams for the majority of the aggregate tests show either random variation or a combination of random variation and laboratory bias for some laboratories.

One hundred and ninety-four of the laboratories that participated in the aggregate tests are also CCIL Type C (low complexity tests) certified and forty-five of those are certified for high complexity tests (Type D). CCIL inspects the certified laboratories for quality control procedures, ability of technicians, and condition and calibration of the equipment at about eighteen month's intervals. The aggregate tests are probably showing general improvement in variation due to the CCIL laboratory inspection, proficiency sample testing, and due to an increased awareness of the importance of proper testing.

The variations found in 2006 for the soil tests are consistent with the values reported in the last three years' studies, but the scatter diagrams still show strong laboratory biases. The results of soil tests are significantly influenced by the operator skills, testing environment, and the condition and calibration of the equipment. Twenty- four of the fifty-six laboratories participated in the soil tests do not participate in the MTO on-site lab inspection program[8], which is voluntary. Most of the laboratories that are in the MTO Vendors list were inspected about five years ago and little re-inspections have been done to date.

The results of 2006 Superpave consensus property tests are not only consistent with the results of previous years, but show improvements in the case of uncompacted void content, and percent fractured particles of coarse aggregate. Further, the multi-laboratory precision, with the exception of uncompacted void content, are noticeably lower than the values published in ASTM precision statements. However, the scatter diagrams show strong laboratory biases. Most of the laboratories participated in this program have limited experience in these test procedures. Its only three years since the CCIL laboratory inspection program was introduced for superpave consensus property tests. This on-site inspection program should bring about improvements in variation and reduce laboratory biases.

8 To arrange an inspection of your Soil Laboratory, please contact Mark Vasavithasan, Soils and Aggregates Section, Ministry of Transportation, phone (416) 235 – 4901, fax (416) 235 – 4101.

6. Recommendations

Although, there are some noticeable reductions in multi-laboratory variation, strong laboratory biases still remain in a number of test procedures. The laboratories that were identified as outliers and obtained zero ratings should examine the condition and calibration of equipment, testing procedures, and skills of the technicians. It is good practice to do this whenever a rating of 2 or less is obtained.

The results of the 2006 MTO Aggregate and Soil Proficiency Sample Program suggest that most laboratories have performed satisfactorily. Those laboratories that obtained relatively low ratings must focus on operator training, standardization and calibration of equipment, and improvements to laboratory environment in order to improve their performance.

For all of the tests that were included in this study, the equipment to be used is regulated by the test method itself. A good state of maintenance, repair and correct calibration are sometimes lacking. It is hoped that the mandatory Quality System implemented by CCIL in the spring of 2002 will encourage laboratories to conduct self-examination to ensure they have the correct equipment and properly trained technicians. Laboratories will find that a well-documented and regular program of internal inspection, calibration, and testing of control or reference samples, are beneficial to maintaining a high level of confidence in their results.

7. Acknowledgments

The authors wish to acknowledge the assistance and dedicated work of the laboratory staff of Soils and Aggregates Section in preparation of samples and performing the tests. We received considerable assistance from the laboratory staff of Bituminous Section and Concrete Section in preparation of correlation samples for distribution.

References

1. American Society for Testing and Materials. Annual Book of ASTM Standards, Vol. 04.02, Concrete and Aggregate
2. American Society for Testing and Materials. Annual Book of ASTM Standards, Vol. 14.02, Statistical Methods
3. Grubbs, F. E. and Beck, G., "Extension of Sample Sizes and Percentage Points for Significance Tests of Outlying Observations", Technometrics, TCMTA, Vol. 14, No. 4, November 1972, pp. 847 – 854.
4. Grubbs, F. E., "Procedures for Detecting Outlying Observations in Samples", Technometrics, TCMTA, Vol. 11, No. 4, February 1969, pp. 1 – 21.
5. Manchester, L., 1979, "The Development of an Interlaboratory Testing Program for Construction Aggregates", Engineering Materials Office Report EM-33, Ministry of Transportation, Ontario
6. Vasavithasan, M. and Rutter, B., 2004, "User's Manual for Soils and Aggregates Sample Testing (SASTP) Computer Program ", Materials Engineering and Research Office Report MERO-013, Ministry of Transportation, Ontario
7. Vasavithasan, M. and Rogers, C. A., 2007, "Precision of Aggregate Test Methods: Does Laboratory Inspection Reduce Multi-Laboratory Variation?", -- in press
8. Vogler, R. H. and Spellenberg, P. A., "AASHTO T 27 – Sieve Analysis of Fine and Coarse Aggregate", AASHTO Technical Section 1c, Unpublished Paper

Appendix A: Glossary of Terms

Precision refers to the degree of mutual agreement between individual measurements on the same material. In other words, precision is a measure of how well the individual test results of a series agree with each other.

Accuracy refers to the degree of mutual agreement between a set of measurements with an accepted reference or 'true value.' This 'true' or reference value can be an assigned value arrived at by actual experiments.

Bias of a measurement process is a consistent and systematic difference between a set of test results derived from using the process, and an accepted reference value of the property being measured. For the majority of aggregate and soil tests there is no acceptable reference material, so bias is impossible to compute.

Critical Value is that value of the sample criterion, which would be exceeded by chance with some specified probability (significance level) on the assumption that all the observations did indeed constitute a random sample from a common system of causes.

Coefficient of Variation expresses the standard deviation as a percentage of the mean, where:

$$C.V. = \frac{\text{std dev}}{\text{mean}} \times 100$$

Single operator precision (one-sigma limit (1s)) indicates the variability, as measured by the deviations above and below the average, of a large group of individual test results when the tests have been made on the same material by a single operator using the same apparatus in the same laboratory over a relatively short time.

Multi-laboratory precision (one-sigma limit (1s)) is a quantitative estimate of the variability of a large group of individual test results when each test has been made in a different laboratory and every effort has been made to make test portions of the material as nearly identical as possible. Under normal circumstances the estimates of the one-sigma limit for multi-laboratory precision are usually larger than those for single operator precision because different operators and different equipment are being used in different laboratories.

Acceptable difference between two results (difference two-sigma limit (d2s)) as an index of precision is the maximum acceptable difference between two results obtained on test portions of the same material tested by two different laboratories. The index, d2s, is the difference between two individual test results that would be equalled or exceeded in only one case in twenty in the normal and correct operation of the method. The index is calculated by multiplying the multi-laboratory standard deviation (1s), by the factor $2\sqrt{2}$ (2.83).

Sample mean or average is the sum of all observations divided by the total number of observations.

Median is synonymous with the middle and the **sample median** is the middle value of a list of test results when the observations are ordered from smallest to largest in magnitude. After rearranging the observations in increasing order (from most negative to most positive), the

sample median is the *single middle value* in the ordered list, if n is odd, or the *average of the two middle values* in the ordered list, if n is even, where n equals the number of observations.

Standard deviation is the most usual measure of the dispersion of observed values or results expressed as the positive square root of the variance.

Variance is a measure of the squared dispersion of observed values or measurements expressed as a function of the sum of the squared deviations from the population mean or sample average.

Outlier is a measurement that, for a specific degree of confidence, is not part of the population. In this study, an outlier is generally three or more standard deviations from the mean, giving a confidence level of ninety-nine percent. If a laboratory test result is classified as an outlier it means something went wrong either with the sample or in the laboratory.

Appendix B1: List of Participants

2006 Participants List Ministry of Transportation Aggregate and Soil Proficiency Sample Testing Program For further information on this program, contact: Mark Vasavithasan (416) 235-4901, or Chris Rogers (416) 235-3734	LS-601 Wash Pass 75µm	LS-602 Sieve Analysis	LS-603 Los Angeles Abrasion	LS-604/5 Relative Density	LS-606 Sulphate Soundness	LS-607 Percent Crushed Particles	LS-608 Percent Flat and Elongated	LS-609 Petrographic Number - Concrete	LS-616 Petrographic Analysis – Fine	LS-614 Freeze-Thaw	LS-618 Micro-Deval CA	LS-619 Micro-Deval FA	LS-620 Accelerated Mortar Bar	LS-621 Asphalt Coated Particles	LS- 623 One Point Proctor Density	LS-702 Particle Size Analysis	LS-703/4 Atterberg Limits	LS-705 Specific Gravity of Soils
A. L. Blair Construction Limited Moose Creek, ON Mr. B. Blanshard Tel: 613 538-2271	✓	✓				✓								✓				
Acculab Engineering and Testing Schumacher, ON Mr. H. R. Jones Tel: 705 360-5252	✓	✓				✓	✓							✓	✓			
AGS Associates Inc. Scarborough, ON Mr. A. Chohan Tel: 416 299-3655	✓	✓		✓	✓	✓	✓				✓	✓		✓	✓	✓	✓	✓
AME - Materials Engineering Brampton, ON Mr. S. Crowley Tel: 905 840-5914	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	
AME - Materials Engineering Gormley, ON Mr. B. Dobson Tel: 905 640-7772	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	
AME - Materials Engineering (24-165) Brampton, ON Mr. S. Crowley Tel: 905 840-5914	✓	✓				✓								✓	✓			
AME - Materials Engineering (24-270) Brampton, ON Mr. S. Crowley Tel: 905 840-5914	✓	✓				✓								✓	✓			
AME - Materials Engineering (24-271) Brampton, ON Mr. S. Crowley Tel: 905 840-5914	✓	✓				✓								✓	✓			
AME - Materials Engineering (24-272) Brampton, ON Mr. S. Crowley Tel: 905 840-5914	✓	✓				✓	✓							✓	✓			
AME - Materials Engineering (24-297) Brampton, ON Mr. S. Crowley Tel: 905 840-5914	✓	✓				✓								✓	✓			
AME - Materials Engineering (24-298) Brampton, ON Mr. S. Crowley Tel: 905 840-5914	✓	✓				✓	✓							✓	✓			
AME - Materials Engineering (24-911) Brampton, ON Mr. S. Crowley Tel: 905 840-5914	✓	✓				✓	✓							✓	✓			
AME - Materials Engineering (24-912) Brampton, ON Mr. S. Crowley Tel: 905 840-5914	✓	✓				✓								✓	✓			
AMEC Earth & Environmental Ltd. Scarborough, ON Mr. S. Sufi Tel: 416 751-6565	✓	✓		✓	✓	✓	✓			✓	✓	✓		✓	✓	✓	✓	✓

2006 Participants List

Ministry of Transportation

Aggregate and Soil

Proficiency Sample

Testing Program

For further information on this program, contact:

Mark Vasavithasan (416) 235-4901, or
Chris Rogers (416) 235-3734

	LS-601 Wash Pass 75µm	LS-602 Sieve Analysis	LS-603 Los Angeles Abrasion	LS-604/5 Relative Density	LS-606 Sulphate Soundness	LS-607 Percent Crushed Particles	LS-608 Percent Flat and Elongated	LS-609 Petrographic Number - Concrete	LS-616 Petrographic Analysis – Fine	LS-614 Freeze-Thaw	LS-618 Micro-Deval CA	LS-619 Micro-Deval FA	LS-620 Accelerated Mortar Bar	LS-621 Asphalt Coated Particles	LS- 623 One Point Proctor Density	LS-702 Particle Size Analysis	LS-703/4 Atterberg Limits	LS-705 Specific Gravity of Soils
AMEC Earth & Environmental Ltd. Hamilton, ON Mr. J. Balinski Tel: 905 312-0700	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
AMEC Earth & Environmental Ltd. Orillia, ON Mr. Don Nicol Tel: 705 329-1542	✓	✓				✓	✓							✓	✓			
AMEC Earth & Environmental Ltd. Thorold, ON Mr. A. Markov Tel: 905 687-6616	✓	✓				✓								✓	✓	✓	✓	✓
AMEC Earth & Environmental Ltd. Waterloo, ON Mr. L. Maier Tel: 519 885-6220	✓	✓		✓		✓	✓				✓	✓		✓	✓	✓	✓	✓
Bernt Gilbertson Enterprises Richards Landing, ON, Mr. S. Eddy Tel: 705 246-2076	✓	✓				✓								✓				
Bertrand Construction L'Original, ON Mr. P. Arnold Tel: 613 675-4614	✓	✓				✓	✓				✓	✓		✓				
Block & Associates Winnipeg, Manitoba Mr. Gordon Richards Tel: 204 334-5356	✓	✓				✓								✓	✓			
BOT Construction Oakville, ON Mr. Vicks Sellathurai Tel: 905 827-3250	✓	✓				✓								✓	✓			
Bruno's Contracting (Thunder Bay) Ltd. Thunder Bay, ON Mr. B. Prevost Tel: 807 623-1855	✓	✓				✓	✓							✓	✓			
C. Villeneuve Construction Hearst, ON Mr. C. Harris Tel: 705 372-1838	✓	✓		✓		✓	✓							✓	✓			
C. T. Soil & Materials Testing Inc. Windsor, ON Mr. T. J. O'Dwyer Tel: 519 966-8863	✓	✓		✓	✓	✓	✓			✓	✓	✓		✓	✓	✓	✓	✓
Caledon Sand & Gravel Ltd. Caledon, ON Mr. D. Glenn Tel: 519 927-5224	✓	✓				✓								✓				
Capital Paving Inc. Guelph, ON Mr. M. Latyn Tel: 519 822-4511	✓	✓				✓	✓							✓				
CBM Aggregates - Aberfoyle Aberfoyle, ON Mr. L. Mugford Tel: 519 824-8169	✓	✓				✓	✓							✓				
CBM Aggregates – Brighton Brighton, ON Mr. L. Mugford Tel: 613 475-2420	✓	✓				✓								✓				
CBM Aggregates – Cambridge Cambridge, ON Mr. L. Mugford Tel: 519 740-3053	✓	✓				✓	✓							✓				
CBM Aggregates – Limehouse Limehouse, ON Mr. L. Mugford Tel: 416 806-3590	✓	✓				✓	✓							✓				

2006 Participants List

Ministry of Transportation

Aggregate and Soil

Proficiency Sample

Testing Program

For further information on this program, contact:

Mark Vasavithasan (416) 235-4901, or
Chris Rogers (416) 235-3734

	LS-601 Wash Pass 75µm	LS-602 Sieve Analysis	LS-603 Los Angeles Abrasion	LS-604/5 Relative Density	LS-606 Sulphate Soundness	LS-607 Percent Crushed Particles	LS-608 Percent Flat and Elongated	LS-609 Petrographic Number - Concrete	LS-616 Petrographic Analysis – Fine	LS-614 Freeze-Thaw	LS-618 Micro-Deval CA	LS-619 Micro-Deval FA	LS-620 Accelerated Mortar Bar	LS-621 Asphalt Coated Particles	LS- 623 One Point Proctor Density	LS-702 Particle Size Analysis	LS-703/4 Atterberg Limits	LS-705 Specific Gravity of Soils
CBM Aggregates – Pinewood Westwood, ON Mr. L. Mugford Tel: 705 295-6843	✓	✓				✓	✓							✓				
CBM Leaside Lab Toronto, ON Mr. S. Parkes Tel: 416 423-2439	✓	✓		✓	✓	✓	✓			✓	✓	✓	✓	✓				
CBM Sunderland Lab Sunderland, ON Mr. L. Mugford Tel: 416 862-1382	✓	✓				✓	✓							✓				
Chung & Vander Dollen Engineering Limited, Kitchener, ON Mr. W. Evans Tel: 519 742-8979	✓	✓		✓	✓	✓	✓			✓	✓	✓		✓	✓	✓	✓	✓
City of Sault Ste Marie Sault Ste Marie, ON Mr. J. Sloan Tel: 705 946-9918	✓	✓				✓								✓				
COCO Paving Inc. Windsor, ON Mr. Ernie Scerbo Tel: 519 948-7133	✓	✓				✓	✓							✓	✓			
Concrete Materials Lab, Dept of Engineering, U. Of Toronto Dr. R. D. Hooton Tel: 416 978-5912													✓					
Construction Control Inc. Woodbridge, ON Mr. A. Davis Tel: 905 856-1438	✓	✓		✓		✓	✓							✓	✓	✓	✓	✓
Construction Testing Asphalt Lab Oakville, ON Mr. P. Lung Tel: 905 469-6352	✓	✓		✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓
Cornwall Gravel Company Limited. Cornwall, ON Mr. B. Mroz Tel: 613 932-6571	✓	✓				✓								✓				
Cox Construction Limited Guelph, ON Mr. Arlaan Warren Tel: 519 824-6570	✓	✓				✓	✓							✓				
Cruickshank Construction Ltd. Kingston, ON Mr. Tim Bilton Tel: 613 542-2874	✓	✓				✓								✓				
Cruickshank Construction Ltd. Morrisburg, ON Mr. D. Byvelds Tel: 613 543-2978	✓	✓				✓	✓							✓	✓			
D. Crupi and Sons Limited Toronto, ON Mr. P. Kandasaami Tel: 416 291-1986	✓	✓		✓		✓	✓							✓				
D. F. Elliott Consulting Engineering New Liskeard, ON Mr. B. Gilbert Tel: 705 647-6871	✓	✓				✓	✓							✓	✓			
Davroc Testing Laboratories Inc. Brampton, ON Mr. S. Fasullo Tel: 905 792-7792	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
DBA Engineering Limited Markham, ON Mr. A. Burleigh Tel: 905 940-8383	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓

2006 Participants List Ministry of Transportation Aggregate and Soil Proficiency Sample Testing Program For further information on this program, contact: Mark Vasavithasan (416) 235-4901, or Chris Rogers (416) 235-3734	LS-601 Wash Pass 75µm	LS-602 Sieve Analysis	LS-603 Los Angeles Abrasion	LS-604/5 Relative Density	LS-606 Sulphate Soundness	LS-607 Percent Crushed Particles	LS-608 Percent Flat and Elongated	LS-609 Petrographic Number - Concrete	LS-616 Petrographic Analysis – Fine	LS-614 Freeze-Thaw	LS-618 Micro-Deval CA	LS-619 Micro-Deval FA	LS-620 Accelerated Mortar Bar	LS-621 Asphalt Coated Particles	LS- 623 One Point Proctor Density	LS-702 Particle Size Analysis	LS-703/4 Atterberg Limits	LS-705 Specific Gravity of Soils
DBA Engineering Limited Mobile 10 Markham, ON Mr. A. Burleigh Tel: 905 940-8383	✓	✓				✓	✓							✓	✓			
DBA Engineering Limited Mobile 5 Markham, ON Mr. A. Burleigh Tel: 905 940-8383	✓	✓				✓	✓							✓	✓			
DBA Engineering Limited Mobile 7 Markham, ON Mr. A. Burleigh Tel: 905 940-8383	✓	✓				✓	✓							✓	✓			
DBA Engineering Ltd. Kingston, ON Mr. M. McClelland Tel: 613 389-1781	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓
District Municipality of Muskoka Bracebridge, ON Mr. D. Wood Tel: 705 645-6764	✓	✓				✓								✓	✓	✓	✓	
Drain Bros Excavating Ltd. Lakefield, ON Mr. D. Drain Tel: 705 639-2301	✓	✓				✓	✓				✓	✓		✓	✓			
DST Consulting Engineers Inc. Kenora, ON Mr. A. Brookes Tel: 807 548-2383	✓	✓				✓	✓							✓	✓			
DST Consulting Engineers Inc. Thunder Bay, ON Mr. Scott Tozer Tel: 807 623-2929	✓	✓		✓		✓	✓			✓	✓	✓		✓	✓	✓	✓	✓
DST Consulting Engineers Inc. Ottawa, ON Mr. J. Lajeunesse Tel: 613 748-1415	✓	✓				✓								✓	✓	✓	✓	
Dufferin Aggregates - Aberfoyle Milton, ON Mr. Maurice Guimont Tel: 905 878-2732	✓	✓				✓	✓							✓				
Dufferin Aggregates - Acton Milton, ON Mr.Maurice Guimont Tel: 905 878-2732	✓	✓				✓	✓							✓				
Dufferin Aggregates - Blair Pit Milton, ON Mr. Maurice Guimont Tel: 905 878-2732	✓	✓				✓	✓							✓				
Dufferin Aggregates - Carden Milton, ON Mr. Maurice Guimont Tel: 905 878-2732	✓	✓				✓	✓							✓				
Dufferin Aggregates - Cayuga Cayuga, ON Mr. Maurice Guimont Tel: 905 772-3331	✓	✓		✓		✓	✓			✓	✓	✓		✓	✓			
Dufferin Aggregates - Flamborough Milton, ON Mr. Maurice Guimont Tel: 905 878-2732	✓	✓				✓	✓							✓				
Dufferin Aggregates - London London, ON Mr. Maurice Guimont Tel: 905 878-2732	✓	✓				✓								✓				
Dufferin Aggregates - Millcreek Milton, ON Mr. Maurice Guimont Tel: 905 878-2732	✓	✓				✓	✓							✓				

2006 Participants List

Ministry of Transportation

Aggregate and Soil

Proficiency Sample

Testing Program

For further information on this program, contact:

Mark Vasavithasan (416) 235-4901, or
Chris Rogers (416) 235-3734

	LS-601 Wash Pass 75µm	LS-602 Sieve Analysis	LS-603 Los Angeles Abrasion	LS-604/5 Relative Density	LS-606 Sulphate Soundness	LS-607 Percent Crushed Particles	LS-608 Percent Flat and Elongated	LS-609 Petrographic Number - Concrete	LS-616 Petrographic Analysis – Fine	LS-614 Freeze-Thaw	LS-618 Micro-Deval CA	LS-619 Micro-Deval FA	LS-620 Accelerated Mortar Bar	LS-621 Asphalt Coated Particles	LS- 623 One Point Proctor Density	LS-702 Particle Size Analysis	LS-703/4 Atterberg Limits	LS-705 Specific Gravity of Soils
Dufferin Aggregates - Milton Milton, ON Mr. Maurice Guimont Tel: 416 798-4772	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓			✓	
Dufferin Aggregates - Mosport Milton, ON Mr. Maurice Guimont Tel: 905 878-2732	✓	✓				✓	✓							✓				
Dufferin Construction Limited - Mobile 1 Oakville, ON Mr. J. Tiwari Tel: 905 827-5750	✓	✓		✓		✓	✓							✓	✓			
Dufferin Construction Limited - Mobile 2 Oakville, ON Mr. J. Tiwari Tel: 905 827-5750	✓	✓		✓		✓	✓							✓	✓			
Dufferin Construction Limited - Mobile 3 Oakville, ON Mr. J. Tiwari Tel: 905 827-5750	✓	✓		✓		✓	✓							✓	✓			
Dufferin Construction Ltd. (QC) - Bronte Oakville, ON Mr. J. Tiwari Tel: 905 827-5750	✓	✓		✓		✓	✓			✓	✓	✓		✓	✓	✓	✓	✓
Dunn Paving Limited Tecumseh, ON Mr. Marcel Gauvin Tel: 519 727-3838	✓	✓				✓								✓	✓			
E. C. King Contracting Lab #1 Owen Sound, ON Mr. H. Villneff Sr. Tel: 705 472-3312	✓	✓				✓	✓							✓	✓			
Esko Savela & Son Contracting Inc. Thunder Bay, ON, Mr. E. Savela Tel: 807 983-2097	✓	✓				✓								✓				
Fermar Construction Limited Rexdale, ON, Mr.Di Francescantonio Tel: 416 675-3550	✓	✓		✓		✓	✓							✓	✓			
Fowler Construction Company Bracebridge, ON Mr. J. Gordon Tel: 705 645-2214	✓	✓		✓		✓	✓				✓	✓		✓	✓			
G. Tackaberry & Sons Construction Co. Ltd., Athens, ON Mr. P. Rodgers Tel: 613 924-2634	✓	✓				✓	✓							✓	✓			
Gamsby and Mannerow Limited Owen Sound, ON Mr. B. Dubeau Tel: 519 376-1805	✓	✓		✓		✓	✓							✓	✓	✓	✓	✓
Gazzola Paving Ltd. Etobicoke, ON Mr. S. Andualem Tel: 416 675-7007	✓	✓		✓		✓	✓							✓				
Geo Terre Limited Brampton, ON Ms. B. Vujanovic Tel: 905 455-5666	✓	✓				✓								✓	✓	✓	✓	
Geo-Logic Inc. Peterborough, ON Mr. W. Rayfuse Tel: 705 749-3317	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓
Geo-Logic Inc. Pembroke, ON Ms. E. Reid Tel: 613 735-8361	✓	✓				✓								✓	✓			

2006 Participants List

Ministry of Transportation
Aggregate and Soil
Proficiency Sample
Testing Program

For further information on this program, contact:

Mark Vasavithasan (416) 235-4901, or
Chris Rogers (416) 235-3734

	LS-601 Wash Pass 75µm	LS-602 Sieve Analysis	LS-603 Los Angeles Abrasion	LS-604/5 Relative Density	LS-606 Sulphate Soundness	LS-607 Percent Crushed Particles	LS-608 Percent Flat and Elongated	LS-609 Petrographic Number - Concrete	LS-616 Petrographic Analysis – Fine	LS-614 Freeze-Thaw	LS-618 Micro-Deval CA	LS-619 Micro-Deval FA	LS-620 Accelerated Mortar Bar	LS-621 Asphalt Coated Particles	LS- 623 One Point Proctor Density	LS-702 Particle Size Analysis	LS-703/4 Atterberg Limits	LS-705 Specific Gravity of Soils
Georgian Aggregates & Construction Collingwood, ON Mr. Tom Risi Tel: 705 445-2300	✓	✓		✓		✓	✓				✓	✓		✓				
Golder Associates Ltd. London, ON Mr. C. Sewell Tel: 519 652-0099	✓	✓		✓		✓	✓			✓	✓	✓		✓	✓	✓	✓	✓
Golder Associates Ltd. Mississauga, ON Ms. M. Manojlovic Tel: 905 567-4444	✓	✓				✓								✓	✓	✓	✓	✓
Golder Associates Ltd. Ottawa, ON Ms. B. Jackson Tel: 613 224-5864	✓	✓		✓	✓	✓	✓							✓	✓	✓	✓	✓
Golder Associates Ltd. Sudbury, ON Ms. Tina Nantel Tel: 705 524-6861	✓	✓		✓		✓	✓							✓	✓	✓	✓	✓
Golder Associates Ltd. Whitby, ON Mr. J. Watkins Tel: 905 723-2727	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
Golder Associates Ltd. Windsor, ON Mr. R. Walsh Tel: 519 250-3733	✓	✓		✓		✓	✓							✓	✓	✓	✓	✓
Graham Brothers Construction Limited Brampton, ON Mr. G. Thompson Tel: 905 453-1200	✓	✓		✓		✓	✓				✓	✓		✓	✓		✓	
Greenwood Aggregates Orangeville, ON Mr. A. Raymond Tel: 519 941-0732	✓	✓		✓		✓	✓							✓				
Hard Rock Paving Company Limited Port Colborne, ON Ms. J. Koros Tel: 905 834-4581	✓	✓		✓		✓	✓				✓	✓		✓	✓			
Harold Sutherland Construction Ltd. Kemble, ON Mr. R. Leigh Tel: 519 376-0603	✓	✓		✓		✓	✓			✓	✓	✓		✓	✓			
Holger Lohse, Consulting Geologist Adjala, ON Mr. Holger Lohse Tel: 519 941-0875								✓	✓									
Huron Construction Lab No. 1 Chatham, ON Mr. D. Smith Tel: 519 354-0170	✓	✓				✓	✓							✓	✓			
Inspec-sol Inc. Kingston, ON Mr. Joseph Bennett Tel: 613 389-9812	✓	✓		✓		✓	✓							✓	✓	✓	✓	✓
Inspec-Sol Inc. Mississauga, ON Mr. K. Roechner Tel: 905 712-4771	✓	✓				✓								✓	✓	✓	✓	
Intratech Engineering Laboratories Inc. Scarborough, ON Mr. F. Miles Tel: 416 754-2077	✓	✓		✓	✓	✓	✓			✓				✓	✓			
J & P Leveque Bros. Haulage Ltd. Bancroft, ON Mr. W. Linnen Tel: 613 332-5533	✓	✓				✓	✓				✓	✓		✓	✓		✓	

2006 Participants List

Ministry of Transportation

Aggregate and Soil

Proficiency Sample

Testing Program

For further information on this program, contact:

Mark Vasavithasan (416) 235-4901, or
Chris Rogers (416) 235-3734

	LS-601 Wash Pass 75µm	LS-602 Sieve Analysis	LS-603 Los Angeles Abrasion	LS-604/5 Relative Density	LS-606 Sulphate Soundness	LS-607 Percent Crushed Particles	LS-608 Percent Flat and Elongated	LS-609 Petrographic Number - Concrete	LS-616 Petrographic Analysis – Fine	LS-614 Freeze-Thaw	LS-618 Micro-Deval CA	LS-619 Micro Deval FA	LS-620 Accelerated Mortar Bar	LS-621 Asphalt Coated Particles	LS- 623 One Point Proctor Density	LS-702 Particle Size Analysis	LS-703/4 Atterberg Limits	LS-705 Specific Gravity of Soils
J & P Leveque Bros. Ltd. - Mobile 1 Bancroft, ON Mr. W. Linnen Tel: 613 332-5533	✓	✓				✓	✓				✓	✓		✓	✓		✓	
Jacques Whitford Limited Ottawa, ON Mr. B. Prevost Tel: 613 738-0708	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
Jacques Whitford Limited Markham, ON Mr. I. Patel Tel: 905 474-7700	✓	✓		✓		✓	✓							✓	✓	✓	✓	✓
John D. Paterson & Associates Nepean, ON Mr. C. Pelletier Tel: 613 226-7381	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓
John D. Patterson & Associates North Bay, ON Mr. Shawn Nelson Tel: 707 472-5331	✓	✓		✓	✓	✓	✓			✓	✓	✓		✓	✓	✓	✓	✓
John Emery Geotechnical Engineering Ltd. Toronto, ON Mr. Dawit Amar Tel: 416 2°3-1060	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
John Emery Geotechnical Engineering - Mobile 4, Toronto, ON Mr. Dawit Amar Tel: 416 213-1060	✓	✓				✓	✓							✓	✓			
K. J. Beamish Construction - Mobile 1 King City, ON Mr. C. Henderson Tel: 905 833-4666	✓	✓				✓	✓							✓	✓			
K. J. Beamish Construction - Mobile 2 Hanmer, ON Mr. C. Henderson Tel: 905 833-4666	✓	✓				✓	✓							✓	✓			
K. J. Beamish Construction King City, ON Mr. C. Henderson Tel: 905 833-4666	✓	✓		✓		✓	✓	✓			✓	✓		✓	✓	✓		
Karson Kartage & Konstruction Stittsville, ON Mr. C. MacDonald Tel: 613 831-0717	✓	✓		✓	✓	✓	✓			✓	✓	✓	✓	✓				
Lafarge Canada Montreal, QUE. Ms. M. de Grosbois Tel: 514 738-1202													✓					
Lafarge Canada - Brechin Plant Brechin, ON Ms. Christine Crumbie Tel: 705 484-5225	✓	✓		✓		✓	✓				✓	✓		✓				
Lafarge Canada - Coldwater Plant Cold Water, ON Ms. Christine Crumbie Tel: 705 484-5225	✓	✓				✓	✓							✓				
Lafarge Canada - Kitchener Kitchener, ON Mr. A. Smith Tel: 519 696-2274	✓	✓		✓		✓	✓							✓				
Lafarge Canada - Mosport Lab Orono, ON Mr. P. Hill Tel: 905 983-9260	✓	✓				✓	✓											
Lafarge Canada - Orillia Lab Brechin, ON Ms. Christine Crumbie Tel: 705 686-7262	✓	✓				✓	✓							✓				

2006 Participants List

Ministry of Transportation

Aggregate and Soil

Proficiency Sample

Testing Program

For further information on this program, contact:

Mark Vasavithasan (416) 235-4901, or
Chris Rogers (416) 235-3734

	LS-601 Wash Pass 75µm	LS-602 Sieve Analysis	LS-603 Los Angeles Abrasion	LS-604/5 Relative Density	LS-606 Sulphate Soundness	LS-607 Percent Crushed Particles	LS-608 Percent Flat and Elongated	LS-609 Petrographic Number - Concrete	LS-616 Petrographic Analysis – Fine	LS-614 Freeze-Thaw	LS-618 Micro-Deval CA	LS-619 Micro-Deval FA	LS-620 Accelerated Mortar Bar	LS-621 Asphalt Coated Particles	LS- 623 One Point Proctor Density	LS-702 Particle Size Analysis	LS-703/4 Atterberg Limits	LS-705 Specific Gravity of Soils
Lafarge Canada Inc - Dundas Quarry Dundas, ON Mr. Ryan Smith Tel: 905 527-3671	✓	✓		✓	✓	✓	✓			✓	✓	✓		✓	✓			
Lafarge Canada Inc. Stouffville, ON Mr. M. Hicks Tel: 905 640-7092	✓	✓		✓		✓	✓							✓	✓			
Lafarge Canada Inc. - Brockville Brockville, ON Mr. P. Arkeveld Tel: 613 342-0262	✓	✓				✓	✓			✓				✓				
Lafarge Canada Inc. - Caledon Caledon, ON Mr. J. Kroeze Tel: 519 927-1113	✓	✓				✓	✓							✓				
Lafarge Canada Inc. - Fonthill Fonthill, ON Mr. J. Vingerhoets Tel: 905 892-2686	✓	✓				✓								✓				
Lafarge Canada Inc. - Hamilton Hamilton, ON Mr. Chris Thomas Tel: 905 522-7735	✓	✓		✓	✓	✓	✓			✓	✓	✓	✓	✓			✓	
Lafarge Canada Inc. - McAdoo Brockville, ON Mr. P. Arkeveld Tel: 613 342-0262	✓	✓				✓	✓							✓				
Lafarge Canada Inc. - Meldrum Meldrum Bay, ON Mr. Jeff Middleton Tel: 705 283-3011	✓	✓				✓	✓							✓				
Lafarge Canada Inc. - Ottawa Ottawa, ON Mr. F. Douglas Tel: 613 837-4223	✓	✓				✓	✓			✓	✓	✓		✓				
Lafarge Canada Inc. - Research lab Mississauga, ON Mr. Paul Lum Tel: 905 819-1290	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓
Lafarge Paving & Construction Toronto, ON Mr. A. Pahalan Tel: 416 633-9670	✓	✓		✓		✓	✓							✓				
Lafarge Paving & Construction (Eastern) Ltd., Belleville, ON Mr. Gary Bates Tel: 613 962-2461	✓	✓		✓		✓	✓			✓	✓	✓		✓	✓		✓	
Lafarge Paving & Construction (Eastern) Ltd., Nepean, ON Mr. B. Gooderham Tel: 613 829-1770	✓	✓		✓		✓	✓				✓	✓		✓				
Lafarge Paving & Construction Limited London, ON Mr. Shawn Dietze Tel: 519 451-2750	✓	✓		✓		✓	✓							✓	✓			
Landtek Limited Hamilton, ON Mr. P. Anderson Tel: 905 383-3733	✓	✓		✓		✓	✓				✓	✓		✓	✓	✓	✓	✓
Lavis Contracting Co. Limited Clinton, ON Mr. A. Gardner Tel: 519 482-3694	✓	✓		✓		✓								✓	✓			
Law Engineering (London) Inc. London, ON Mr. J. Law Tel: 519 680-9991	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓

2006 Participants List

Ministry of Transportation

Aggregate and Soil

Proficiency Sample

Testing Program

For further information on this program, contact:

Mark Vasavithasan (416) 235-4901, or
Chris Rogers (416) 235-3734

	LS-601 Wash Pass 75µm	LS-602 Sieve Analysis	LS-603 Los Angeles Abrasion	LS-604/5 Relative Density	LS-606 Sulphate Soundness	LS-607 Percent Crushed Particles	LS-608 Percent Flat and Elongated	LS-609 Petrographic Number - Concrete	LS-616 Petrographic Analysis – Fine	LS-614 Freeze-Thaw	LS-618 Micro-Deval CA	LS-619 Micro-Deval FA	LS-620 Accelerated Mortar Bar	LS-621 Asphalt Coated Particles	LS- 623 One Point Proctor Density	LS-702 Particle Size Analysis	LS-703/4 Atterberg Limits	LS-705 Specific Gravity of Soils
Leo Alarie and Sons Ltd. - ENG. 10160 Timmins, ON Mr. J. Luthe Tel: 705 268-2106	✓	✓				✓	✓							✓				
Leo Alarie and Sons Ltd. - Mobile 10060 Timmins, ON Mr. J. Luthe Tel: 705 268-2106	✓	✓				✓	✓							✓				
M. J. Labelle Co. Limited - Mobile 1 Cochrane, ON Mr. P. Osmar Tel: 705 272-4201	✓	✓				✓								✓	✓			
M. J. Labelle Co. Limited - Mobile 2 Cochrane, ON Mr. P. Osmar Tel: 705 272-4201	✓	✓				✓								✓	✓			
M. R. Wright & Associates Sault Ste. Marie, ON Mr. Tyler Moody Tel: 705 945-5091	✓	✓		✓		✓	✓				✓	✓		✓	✓	✓	✓	
McAsphalt Engineering Services Toronto, ON Mr. K. Davidson Tel: 416 281-8181	✓	✓		✓		✓	✓							✓	✓			
Merlex Engineering Limited North Bay, ON Mr. J. P. Duhaime Tel: 705 476-2550	✓	✓				✓								✓	✓	✓	✓	✓
Mill-Am Corporation - Mobile 890901 Oldcastle, ON Mr. H. Villneff Sr. Tel: 519 945-7441	✓	✓		✓		✓	✓							✓	✓			
Miller Northwest - Mobile 1 Dryden, ON Mr. H. Villneff Sr. Tel: 807 223-2844	✓	✓		✓		✓	✓							✓	✓			
Miller Northwest - Mobile 87526 Dryden, ON Mr. H. Villneff Sr. Tel: 807 223-2844	✓	✓		✓		✓	✓							✓	✓			
Miller Paving Limited - Carden Quarry Markham, ON Mr. N. Hanasoge Tel: 905 475-6660	✓	✓				✓	✓							✓				
Miller Paving Limited - Markham Markham, ON Mr. N. Hanasoge Tel: 905 475-6660	✓	✓		✓	✓	✓	✓			✓	✓	✓		✓	✓		✓	
Miller Paving Limited - Mobile 8661 North Bay, ON Mr. H. Villneff Sr. Tel: 705 472-3312	✓	✓		✓		✓	✓							✓	✓			
Miller Paving Limited - Whitby Markham, ON Mr. N. Hanasoge Tel: 905 475-6660	✓	✓		✓		✓	✓							✓	✓			
Miller Paving Northern - Mobile 1084 North Bay, ON Mr. H. Villneff Sr. Tel: 705 267-1107	✓	✓		✓		✓	✓							✓	✓			
Miller Paving Northern - Mobile 1254 New Liskeard, ON Mr. H. Villneff Sr. Tel: 705 647-4331	✓	✓				✓								✓	✓			
Miller Paving Northern - Mobile 60889 New Liskeard, ON Mr. H. Villneff Sr. Tel: 705 647-4331	✓	✓		✓		✓	✓							✓	✓			

2006 Participants List

Ministry of Transportation

Aggregate and Soil

Proficiency Sample

Testing Program

For further information on this program, contact:

Mark Vasavithasan (416) 235-4901, or
Chris Rogers (416) 235-3734

	LS-601 Wash Pass 75µm	LS-602 Sieve Analysis	LS-603 Los Angeles Abrasion	LS-604/5 Relative Density	LS-606 Sulphate Soundness	LS-607 Percent Crushed Particles	LS-608 Percent Flat and Elongated	LS-609 Petrographic Number - Concrete	LS-616 Petrographic Analysis – Fine	LS-614 Freeze-Thaw	LS-618 Micro-Deval CA	LS-619 Micro-Deval FA	LS-620 Accelerated Mortar Bar	LS-621 Asphalt Coated Particles	LS- 623 One Point Proctor Density	LS-702 Particle Size Analysis	LS-703/4 Atterberg Limits	LS-705 Specific Gravity of Soils
Miller Paving Northern - Mobile 60900 North Bay, ON Mr. H. Villneff Sr. Tel: 705 267-1107	✓	✓		✓		✓	✓							✓	✓			
Ministry of Transportation Downsview, ON Mr. C. Rogers Tel: 416 235-3734	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MNA Engineering Limited Scarborough, ON Mr. P. Balendran Tel: 416 757-8882	✓	✓		✓		✓	✓							✓	✓	✓	✓	✓
National Testing Laboratories Limited Winnipeg, Manitoba Mr. D. Flatt Tel: 204 488-6999	✓	✓	✓	✓		✓								✓	✓	✓	✓	
Naylor Engineering Associates Limited Kitchener, ON Ms. Anne Allen Tel: 519 741-1313	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓
Naylor Engineering Associates Limited Branford, ON Mr. Tom Staple Tel: 519 720-0078	✓	✓				✓	✓							✓	✓	✓		
Naylor Engineering Associates Limited Stratford, ON Mr. Dennis Kelly Tel: 519 271-0101	✓	✓				✓								✓	✓	✓	✓	
Nelson Aggregate Co. Beamsville, ON Mr. T. Scambato Tel: 905 563-8226	✓	✓				✓	✓							✓				
Nelson Aggregate Co. Burlington, ON Mr. Steve Drew Tel: 905 335-5251	✓	✓				✓	✓							✓				
Peto MacCallum Limited Barrie, ON Mr. T. Lee-Bun Tel: 705 734-3900	✓	✓		✓		✓	✓							✓	✓	✓	✓	✓
Peto MacCallum Limited Brampton, ON Mr. G. Uwimana Tel: 905 796-3650	✓	✓		✓		✓	✓							✓	✓			
Peto MacCallum Limited Hamilton, ON Mr. E. L. Truax Tel: 905 561-2231	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
Peto MacCallum Limited Kitchener, ON Mr. T. Smith Tel: 519 893-7500	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓		✓	✓	✓	✓	✓
Peto MacCallum Limited Toronto, ON Mr. G. Uwimana Tel: 416 785-5110	✓	✓		✓		✓	✓							✓	✓	✓	✓	✓
Pioneer Construction Inc. Sault Ste. Marie, ON Ms. S. Geiling Tel: 705 541-2280	✓	✓		✓		✓	✓			✓	✓	✓		✓	✓			
Pioneer Construction Inc. Sudbury, ON Mr. David Pilkey Tel: 705 560-7200	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓		✓	✓		✓	✓
Pioneer Construction Inc. - Mobile 1 Sudbury, ON Mr. David Pilkey Tel: 705 560-7200	✓	✓				✓	✓							✓	✓			

2006 Participants List

Ministry of Transportation
Aggregate and Soil
Proficiency Sample
Testing Program

For further information on this program, contact:

Mark Vasavithasan (416) 235-4901, or
Chris Rogers (416) 235-3734

	LS-601 Wash Pass 75µm	LS-602 Sieve Analysis	LS-603 Los Angeles Abrasion	LS-604/5 Relative Density	LS-606 Sulphate Soundness	LS-607 Percent Crushed Particles	LS-608 Percent Flat and Elongated	LS-609 Petrographic Number - Concrete	LS-616 Petrographic Analysis – Fine	LS-614 Freeze-Thaw	LS-618 Micro-Deval CA	LS-619 Micro-Deval FA	LS-620 Accelerated Mortar Bar	LS-621 Asphalt Coated Particles	LS- 623 One Point Proctor Density	LS-702 Particle Size Analysis	LS-703/4 Atterberg Limits	LS-705 Specific Gravity of Soils
Pioneer Construction Inc. - Mobile 2 Sudbury, ON Mr. David Pilkey Tel: 705 560-7200	✓	✓				✓	✓							✓	✓			
Pioneer Construction Inc. - Mobile 3 Sault Ste. Marie, ON Ms. S. Geiling Tel: 705 541-2280	✓	✓				✓	✓							✓	✓			
Pioneer Construction Inc. - Mobile B4/C4 Sault Ste. Marie, ON Ms. S. Geiling Tel: 705 541-2280	✓	✓				✓	✓							✓	✓			
Pioneer Construction Inc. - Mobile C 1 Sault Ste. Marie, ON Ms. S. Geiling Tel: 705 541-2280	✓	✓				✓	✓							✓	✓			
Pioneer Construction Inc. - Mobile C 2 Sault Ste. Marie, ON Ms. S. Geiling Tel: 705 541-2280	✓	✓				✓	✓							✓	✓			
Pioneer Construction Inc. - Thunder Bay Sault Ste. Marie, ON Ms. S. Geiling Tel: 705 541-2280	✓	✓		✓		✓	✓							✓	✓			
Precision Age Aggregate Testing Ltd. Thunder Bay, ON Mr. W. Werbowetski Tel: 807 577-3927								✓	✓									
Preston Sand & Gravel Kitchener, ON Mr. M. Bell Tel: 519 579-1248	✓	✓				✓	✓							✓				
R. W. Tomlinson Limited Gloucester, ON Mr. B. Hendriks Tel: 613 822-1867	✓	✓		✓		✓	✓			✓	✓	✓		✓	✓		✓	✓
R.S Wilson Materials Testing & Inspection Sault Ste. Marie, ON Mr. Robert Wilson Tel: 705 759-2881	✓	✓				✓								✓	✓			
Regional Municipality of Durham Whitby, ON Mr. Joeman Ng Tel: 905 655-3344	✓	✓				✓	✓							✓	✓			
Sarafinchin Associates Limited Rexdale, ON Mr. S. Jeffrey Tel: 416 674-1770	✓	✓		✓		✓	✓							✓	✓	✓	✓	✓
Shaba Testing Services Limited Chaput Hughes, ON Mr. L. Shaba Tel: 705 567-4187	✓	✓				✓								✓	✓			
Shaheen & Peaker Limited Toronto, ON Mr. A. Mendonca Tel: 416 213-1255	✓	✓				✓	✓							✓	✓	✓	✓	✓
Shaheen & Peaker Limited (Geo-Canada) Markham, ON Mr. S. Peaker Tel: 905 474-9255	✓	✓				✓	✓								✓	✓	✓	✓
Shaheen Peaker Thompson Limited Oshawa ON Mr. D. Thompson Tel: 905 436-9028	✓	✓		✓	✓	✓	✓			✓				✓	✓	✓	✓	✓
Site Investigation Services, Division of Jagger Hims Ltd, Peterborough, ON Mr. S. Ash Tel: 705 743-6850	✓	✓				✓								✓	✓		✓	

2006 Participants List

Ministry of Transportation

Aggregate and Soil

Proficiency Sample

Testing Program

For further information on this program, contact:

Mark Vasavithasan (416) 235-4901, or
Chris Rogers (416) 235-3734

	LS-601 Wash Pass 75µm	LS-602 Sieve Analysis	LS-603 Los Angeles Abrasion	LS-604/5 Relative Density	LS-606 Sulphate Soundness	LS-607 Percent Crushed Particles	LS-608 Percent Flat and Elongated	LS-609 Petrographic Number - Concrete	LS-616 Petrographic Analysis – Fine	LS-614 Freeze-Thaw	LS-618 Micro-Deval CA	LS-619 Micro-Deval FA	LS-620 Accelerated Mortar Bar	LS-621 Asphalt Coated Particles	LS- 623 One Point Proctor Density	LS-702 Particle Size Analysis	LS-703/4 Atterberg Limits	LS-705 Specific Gravity of Soils
Smelter Bay Aggregates Inc. Thessalon, ON Mr. C. Hernden Tel: 705 842-3908	✓	✓				✓	✓							✓				
Smith's Construction - Mobile 50612 Arnprior, ON Mr. Frank Gainer Tel: 613 623-3144	✓	✓		✓		✓	✓							✓	✓			
Smith's Construction - Mobile 60853 Arnprior, ON Mr. Frank Gainer Tel: 613 623-3144	✓	✓		✓		✓	✓							✓	✓			
Smith's Construction - Mobile 8660 Arnprior, ON Mr. Frank Gainer Tel: 613 623-3144	✓	✓		✓		✓	✓							✓	✓			
Soil Engineers Limited Scarborough, ON Mr. S. Sanjeevan Tel: 416 754-8515	✓	✓				✓	✓							✓	✓	✓	✓	✓
St Lawrence Testing & Inspection Co. Ltd Cornwall, ON Mr. G. McIntee Tel: 613 938-2521	✓	✓		✓		✓	✓				✓	✓		✓	✓	✓	✓	✓
Steed and Evans Limited Heidelberg, ON Mr. R. Marco Tel: 519 699-4646	✓	✓				✓	✓							✓				
Sutcliffe Rody Quesnel Limited New Liskeard, ON Mr. Dan Cook Tel: 705 647-4311	✓	✓				✓	✓							✓	✓			
Teranorth Construction & Engineering Limited, Sudbury, ON Mr. James Bot Tel: 705 523-1540	✓	✓				✓	✓							✓	✓			
Terraprobe Testing Limited Brampton, ON Ms. Valerie Rose Tel: 905 796-2650	✓	✓		✓		✓	✓	✓						✓	✓	✓	✓	✓
Terraprobe Testing Limited Barrie, ON Mr. B. Jackson Tel: 705 739-8355	✓	✓		✓		✓	✓							✓	✓	✓	✓	✓
Terraprobe Testing Limited Stoney Creek, ON Mr. G. Muckle Tel: 905 643-7560	✓	✓		✓	✓	✓	✓			✓	✓	✓		✓	✓	✓	✓	✓
Terraprobe Testing Limited Sudbury, ON Mr. R. Carniello Tel: 705 670-0460	✓	✓				✓								✓	✓	✓	✓	
Terraspec Engineering Peterborough, ON Mr. S. Galloway Tel: 705 743-7880	✓	✓				✓								✓	✓	✓	✓	✓
The Miller Group Materials Research Lab Markham, ON Mr. N. Hanasoge Tel: 905 475-6660	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	
The Murray Group Moorefield, ON Mr. Chris Hodgson Tel: 519 638-3077	✓	✓				✓	✓							✓				
Thomas Cavanagh Construction Ltd. Ashton, ON Mr. P. White Tel: 613 259-2670	✓	✓				✓								✓				

2006 Participants List Ministry of Transportation Aggregate and Soil Proficiency Sample Testing Program For further information on this program, contact: Mark Vasavithasan (416) 235-4901, or Chris Rogers (416) 235-3734	LS-601 Wash Pass 75µm	LS-602 Sieve Analysis	LS-603 Los Angeles Abrasion	LS-604/5 Relative Density	LS-606 Sulphate Soundness	LS-607 Percent Crushed Particles	LS-608 Percent Flat and Elongated	LS-609 Petrographic Number - Concrete	LS-616 Petrographic Analysis – Fine	LS-614 Freeze-Thaw	LS-618 Micro-Deval CA	LS-619 Micro-Deval FA	LS-620 Accelerated Mortar Bar	LS-621 Asphalt Coated Particles	LS- 623 One Point Proctor Density	LS-702 Particle Size Analysis	LS-703/4 Atterberg Limits	LS-705 Specific Gravity of Soils
Thunder Bay Testing and Engineering Thunder Bay, ON Mr. T. Fummerton Tel: 807 624-5162	✓	✓		✓		✓	✓			✓	✓	✓		✓	✓	✓	✓	✓
Thurber Engineering Limited Oakville, ON Dr. P. K. Chatterji Tel: 905 829-8666	✓	✓				✓								✓	✓	✓	✓	✓
Trow Associates Inc. Brampton, ON Mr. S. Lee Tel: 905 793-9800	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Trow Associates Inc. London, ON Ms. R. Walker Tel: 519 453-1480	✓	✓				✓	✓							✓	✓			
Trow Associates Inc. Stoney Creek, ON Mr. C. Douglas Tel: 905 664-3300	✓	✓				✓	✓							✓	✓	✓	✓	
Trow Associates Inc. Sudbury, ON Mr. R. Ferguson Tel: 705 674-9681	✓	✓		✓		✓	✓			✓	✓	✓		✓	✓	✓	✓	✓
Trow Associates Inc. Nepean, ON Mr. I. M. Taki Tel: 613 225-9940	✓	✓		✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓
Trow Associates Inc. Thunder Bay, ON Mr. K. Mosley Tel: 807 623-9495	✓	✓		✓		✓	✓			✓	✓	✓		✓	✓	✓	✓	
Trow Associates Inc. Barrie, ON Mr. L. Knegt Tel: 705 734-6222	✓	✓				✓	✓							✓	✓			
Vicdom Sand and Gravel Limited Uxbridge, ON Mr. B. Giordano Tel: 905 649-2193	✓	✓				✓	✓							✓				
Walker Brothers Quarries Limited Thorold, ON Mr. Tom Risi Tel: 905 680-3750	✓	✓		✓		✓	✓				✓	✓		✓				

Appendix B2: List of Participants

2006 Participants List Ministry of Transportation Superpave Aggregate Consensus Property Testing Program For further information on this program Contact Chris Rogers at (416) 235-3734	ASTM D 1252/AASHTO T 304 - Uncompacted Void Content of Fine Aggregate	ASTM D 4219/AASHTO T 176 – Sand Equivalent Value of Fine Aggregate	ASTM D 5821 – Percent of Fractured Particles in Coarse Aggregate	ASTM D 4791 – Percent Flat Particles, Elongated Particles or Flat & Elongated Particles in Coarse Aggregate
AME -Materials Engineering Brampton, ON Mr. B. Dobson Tel: 905 640-7772	✓	✓	✓	✓
AME -Materials Engineering Brampton, ON Mr. S. Crowley Tel: 905 840-5914	✓	✓	✓	✓
AMEC Earth & Environmental Limited Hamilton, ON Mr. J. Balinski Tel: 905 312-0700	✓	✓	✓	✓
AMEC Earth & Environmental Limited Scarborough, ON Mr. S. Sufi Tel: 416 751-6565	✓	✓	✓	✓
Block & Associates Winnipeg, MB Mr. Gordon Richards Tel: 204 334-5356			✓	
Bruno's Contacting (Thunder Bay) Limited Thunder Bay, ON Mr. B. Prevost Tel: 807 623-1855	✓	✓	✓	✓
Construction Testing Asphalt Lab Oakville, ON Mr. P. Lung Tel: 905 469-6352	✓	✓	✓	✓
DBA Engineering Limited Kingston, ON Mr. M. McClelland Tel: 613 389-1781	✓	✓	✓	✓
DBA Engineering Limited Markham, ON Mr. A. Burleigh Tel: 905 940-8383	✓	✓	✓	✓
DST Consulting Engineers Inc. Thunder Bay, ON Mr. Scott Tozer Tel: 807 623-2929	✓	✓	✓	✓
Dufferin Aggregates - Cayuga Milton, ON Maurice Guimont Tel: 416 798-4772			✓	✓
Dufferin Aggregates - Milton Milton, ON Maurice Guimont Tel: 416 798-4772	✓	✓	✓	✓
Dufferin Construction Ltd. - Mobile 3 Oakville, ON Mr. J. Tiwari Tel: 905 827-5750	✓	✓	✓	✓
Dufferin Construction Ltd. (QC) - Bronte Oakville, ON Mr. J. Tiwari Tel: 905 827-5750	✓	✓	✓	✓
Fowler Construction Company Bracebridge, ON Mr. J. Gordon Tel: 705 645-2214	✓	✓	✓	✓
Geo-Logic Inc. Peterborough, ON Mr. W. Rayfuse Tel: 705 749-3317	✓	✓	✓	✓
Golder Associates Limited London, ON Mr. C. Sewell Tel: 519 652-0099	✓	✓	✓	✓
Golder Associates Limited Sudbury, ON Ms. Tina Nantel Tel: 705 524-6861	✓	✓	✓	✓
Golder Associates Limited Whitby, ON Mr. J. Watkins Tel: 905 723-2727	✓	✓	✓	✓

2006 Participants List Ministry of Transportation Superpave Aggregate Consensus Property Testing Program For further information on this program Contact Chris Rogers at (416) 235-3734	ASTM D 1252/AASHTO T 304 - Uncompacted Void Content of Fine Aggregate	ASTM D 4219/AASHTO T 176 – Sand Equivalent Value of Fine Aggregate	ASTM D 5821 – Percent of Fractured Particles in Coarse Aggregate	ASTM D 4791 – Percent Flat Particles, Elongated Particles or Flat & Elongated Particles in Coarse Aggregate
Graham Bros. Construction Limited Brampton, ON Mr. G. Thompson Tel: 905 453-1200	✓	✓	✓	✓
Hard Rock Paving Company Limited Port Colborne, ON Ms. J. Koros Tel: 905 834-4581	✓	✓	✓	✓
Harold Sutherland Construction Limited Kemble, ON Mr. R. Leigh Tel: 519 376-0603	✓	✓	✓	✓
Jacques Whitford Limited Ottawa, ON Mr. B. Prevost Tel: 613 738-0708	✓	✓	✓	✓
John D. Patterson & Associates North Bay, ON Mr. Shawn Nelson Tel: 705 472-5331	✓	✓	✓	✓
John Emery Geotechnical Engineering Ltd Toronto, ON Mr. Dawit Amar Tel: 416 213-1060	✓	✓	✓	✓
K. J. Beamish Construction King City, ON Mr. C. Henderson Tel: 905 833-4666	✓	✓	✓	✓
Karson Kartage & Konstruction Stittsville, ON Mr. C. MacDonald Tel: 613 831-0717	✓	✓	✓	✓
Lafarge Canada Inc. – Dundas Quarry Dundas, ON Mr. Ryan Smith Tel: 905 527-3671	✓		✓	✓
Lafarge Canada Inc. - Hamilton Hamilton, ON Mr. Chris Thomas Tel: 905 522-7735	✓		✓	✓
Lafarge Canada Inc. - Research Lab Mississauga, ON Mr. Paul Lum Tel: 905 819-1290	✓	✓	✓	✓
Lafarge Paving & Construction (Eastern) Limited Belleville, ON Mr. Gary Bates Tel: 613 962-2461	✓	✓	✓	✓
Lafarge Paving & Construction (Eastern) Limited Toronto, ON Mr. Andrew Pahalan Tel: 416 633-9670	✓	✓	✓	✓
Lafarge Paving & Construction Limited London, ON Mr. Shawn Dietze Tel: 519 451-2750	✓	✓	✓	✓
Lavis Contracting Co. Limited Clinton, ON Mr. R. Ferguson Tel: 519 482-3694	✓	✓	✓	✓
McAsphalt Engineering Services Toronto, ON Mr. K. Davidson Tel: 416 282-8181	✓	✓	✓	✓
Mill-Am Corporation - Mobile 890901 Oldcastle, ON Mr. H. Villlneff Sr. Tel: 519 945-7441	✓	✓	✓	✓
Miller Northwest - Mobile 1 Dryden, ON Mr. H. Villlneff Sr. Tel: 807 223-2844	✓	✓	✓	✓
Miller Northwest - Mobile 87526 Dryden, ON Mr. H. Villlneff Sr. Tel: 807 223-2844	✓	✓	✓	✓
Miller Paving Limited - Markham Markham, ON Mr. N. Hanasoge Tel: 905 475-6660	✓	✓	✓	✓
Miller Paving Northern - Mobile 1084 North Bay, ON Mr. H. Villneff Sr. Tel: 705 267-1107	✓	✓	✓	✓
Miller Paving Northern - Mobile 60889 New Liskeard, ON Mr. H. Villneff Sr. Tel: 705 647-4331	✓	✓	✓	✓

2006 Participants List Ministry of Transportation Superpave Aggregate Consensus Property Testing Program For further information on this program Contact Chris Rogers at (416) 235-3734	ASTM D 1252/AASHTO T 304 - Uncompacted Void Content of Fine Aggregate	ASTM D 4219/AASHTO T 176 – Sand Equivalent Value of Fine Aggregate	ASTM D 5821 – Percent of Fractured Particles in Coarse Aggregate	ASTM D 4791 – Percent Flat Particles, Elongated Particles or Flat & Elongated Particles in Coarse Aggregate
Miller Paving Northern - Mobile 60900 New Liskeard, ON Mr. H. Villneff Sr. Tel: 705 647-4331	✓	✓	✓	✓
Ministry of Transportation Downsview, ON Mr. C. Rogers Tel: 416 235-3734	✓	✓	✓	✓
Peto MacCallum Limited Hamilton, ON Mr. E. L. Truax Tel: 905 561-2231	✓	✓	✓	✓
Peto MacCallum Limited Kitchener, ON Mr. T. Smith Tel: 519 893-7500	✓	✓	✓	✓
Peto MacCallum Limited Toronto, ON Mr. A. Nathoo Tel: 416 785-5110	✓	✓	✓	✓
Pioneer Construction Inc. Sault Ste. Marie, ON Mrs. S. Geiling Tel: 705 541-2280	✓	✓	✓	✓
Pioneer Construction Inc. Sudbury, ON Mr. David Pilkey Tel: 705 560-7200	✓	✓	✓	✓
R. W. Tomlinson Limited Gloucester, ON Mr. B. Hendriks Tel: 613 822-1867	✓	✓	✓	✓
Smiths Construction - Mobile 50612 Arnprior, ON Mr. Frank Gainer Tel: 519 482-3694	✓	✓	✓	✓
St Lawrence Testing & Inspection Co. Ltd Cornwall, ON Mr. G. McIntee Tel: 613 938-2521	✓	✓	✓	✓
Terraprobe Testing Limited Brampton, ON Ms. Valerie Rose Tel: 905 796-2650	✓	✓	✓	✓
The Miller Group Materials Research Lab Markham, ON Mr. N. Hanasoge Tel: 905 475-6660	✓	✓	✓	✓
Thunder Bay Testing and Engineering Ltd. Thunder Bay, ON Mr. T. Fummerton Tel: 807 624-5162	✓	✓	✓	✓
Trow Associates Inc. Brampton, ON Mr. S. Lee Tel: 905 793-9800	✓	✓	✓	✓
Trow Associates Inc. Nepean, ON Mr. I. M. Taki Tel: 613 225-9940	✓	✓	✓	✓
Trow Associates Inc. Sudbury, ON Mr. R. Ferguson Tel: 705 674-9681	✓	✓	✓	✓

Appendix C: Multi-Laboratory Precision

Test 1	2003		2004		2005		2006		ASTM C117
WP 75 µm	1.03	2.03	1.04	2.04	1.05	2.05	1.06	2.06	
Mean	1.09	1.22	1.01	1.03	1.18	1.16	1.36	1.46	<1.5
1S	0.30	0.28	0.15	0.13	0.23	0.26	0.27	0.28	0.22
D2S	0.85	0.80	0.43	0.37	0.65	0.73	0.77	0.81	0.62
n/Outliers	197/6		197/6		192/12		200/8		

Test 2	2003		2004		2005		2006		ASTM C136[A]
P 19.0 mm	1.03	2.03	1.04	2.04	1.05	2.05	1.06	2.06	
Mean	99.0	99.0	97.7	97.6	92.8	91.8	95.6	95.6	100 - 95
1S	0.3	0.3	0.5	0.6	1.1	1.1	0.8	0.7	0.35
D2S	0.9	0.9	1.5	1.8	3.1	3.2	2.4	2.1	1.0
n/Outliers	198/6		203/1		206/0		208/0		

Test 3	2003		2004		2005		2006		ASTM C136[A]
P 16.0 mm	1.03	2.03	1.04	2.04	1.05	2.05	1.06	2.06	
Mean	94.6	94.5	89.5	89.0	84.6	82.9	88.2	88.1	95 - 85
1S	0.8	0.7	1.3	1.4	1.3	1.4	1.1	0.9	1.37
D2S	2.2	2.2	3.6	3.9	3.6	4.1	3.2	2.5	3.9
n/Outliers	202/2		203/1		204/2		200/8		

Test 4	2003		2004		2005		2006		ASTM C136[A]
P 13.2 mm	1.03	2.03	1.04	2.04	1.05	2.05	1.06	2.06	
Mean	88.0	87.8	79.8	78.9	77.5	75.4	81.5	81.3	85 - 80
1S	1.1	1.1	1.8	2.1	1.4	1.5	1.3	1.0	1.92
D2S	3.2	3.2	5.2	5.9	4.1	4.1	3.6	2.8	5.4
n/Outliers	201/3		203/1		204/2		207/1		

Test 5	2003		2004		2005		2006		ASTM C136[A]
P 9.5 mm	1.03	2.03	1.04	2.04	1.05	2.05	1.06	2.06	
Mean	74.9	74.8	64.8	63.6	66.2	63.8	70.5	70.5	80 – 60
1S	1.2	1.3	2.0	2.5	1.5	1.6	1.4	1.1	2.82
D2S	3.4	3.7	5.6	7.1	4.2	4.4	4.0	3.2	8.0
n/Outliers	200/4		201/3		204/2		205/3		

Test 6	2003		2004		2005		2006		ASTM C136[A]
P 4.75 mm	1.03	2.03	1.04	2.04	1.05	2.05	1.06	1.06	
Mean	55.7	56.1	47.5	46.6	49.9	47.8	55.5	55.5	60 – 20
1S	1.4	1.5	1.9	2.4	1.4	1.6	1.3	1.0	1.97
D2S	4.0	4.3	5.5	6.7	3.9	4.4	3.6	2.8	5.6
n/Outliers	198/5		203/1		203/3		204/4		

Test 8	2003		2004		2005		2006		ASTM C131	
L. L. A	1.03	2.03	1.04	2.04	1.05	2.05	1.06	2.06	C of V	σ'
Mean	23.70	24.36	21.54	21.27	23.44	23.19	18.47	18.15	10-45	18.3
1S	2.07	1.39	0.91	1.45	1.08	1.41	1.51	1.94	4.5%	0.82
D2S	5.87	3.94	2.57	4.09	3.05	3.97	4.26	5.50	12.7%	2.33
n/Outliers	11/1		9/2		11/0		10/0			

A – AMRL reports percent passing inch series equivalent sieves.

σ' - Calculated from Coefficient of Variation Precision Statement (Coefficient of Variation = Standard Deviation / Mean)

Test 9	2003		2004		2005		2006		ASTM C127
RD (O.D)	1.03	2.03	1.04	2.04	1.05	2.05	1.06	2.06	
Mean	2.669	2.668	2.687	2.686	2.660	2.660	2.669	2.669	
1S	0.007	0.007	0.006	0.006	0.007	0.009	0.005	0.006	0.013
D2S	0.020	0.020	0.017	0.017	0.020	0.025	0.014	0.017	0.038
n/Outliers	86/3		89/6		92/5		91/10		

Test 10	2003		2004		2005		2006		ASTM C127 - 88
ABS	1.03	2.03	1.04	2.04	1.05	2.05	1.06	2.06	
Mean	0.697	0.710	0.463	0.470	1.544	1.549	1.840	1.835	< 2%
1S	0.079	0.078	0.064	0.073	0.143	0.167	0.093	0.081	0.145
D2S	0.223	0.221	0.181	0.206	0.403	0.471	0.263	0.229	0.41
n/Outliers	87/2		91/4		93/4		92/9		

Test 11	2003		2004		2005		2006		ASTM C88	
MgSO4	1.03	2.03	1.04	2.04	1.05	2.05	1.06	2.06	C of V	σ'
Mean	13.8	13.8	5.4	5.2	13.6	13.5	7.5	7.5	9-20%	7.5
1S	3.4	3.0	2.0	1.7	3.4	3.0	2.2	2.1	25%	1.9
D2S	9.7	8.5	5.7	4.7	9.5	8.4	6.4	5.9	71%	5.3
n/Outliers	34/1		34/1		31/1		36/1			

Test 12	2003		2004		2005		2006		MTO Workshop
% Crush	1.03	2.03	1.04	2.04	1.05	2.05	1.06	2.06	
Mean	64.3	64.7	69.2	69.7	68.7	69.1	74.3	74.2	50 - 75
1S	5.4	5.8	4.7	4.9	5.3	5.6	4.2	4.3	6.0%
D2S	15.4	16.5	13.5	13.9	14.8	15.8	11.8	12.3	16.9%
n/Outliers	197/5		188/15		201/3		196/12		

Test 13	2003		2004		2005		2006		ASTM D 4791
% F & E	1.03	2.03	1.04	2.04	1.05	2.05	1.06	2.06	
Mean	3.8	3.6	9.2	8.9	6.5	6.2	9.7	8.9	No ASTM
1S	2.6	2.2	3.7	3.5	3.0	2.7	3.4	3.5	Precision
D2S	7.3	6.2	10.5	9.9	8.5	7.8	9.7	10.0	Statements for
n/Outliers	158/4		160/7		162/6		163/6		this test

Test 14	2003		2004		2005		2006		ASTM
PN Conc.	1.03	2.03	1.04	2.04	1.05	2.05	1.06	2.06	
Mean	Analysis		150.9	145.3	Analysis		122.7	120.9	No ASTM
1S	Not		6.9	12.3	Not		7.9	7.7	Standard for this
D2S	Done		19.6	34.9	Done		22.3	21.8	Test.
n/Outliers			20/6				25/0		
							150.9	145.3	

Test 16	2003		2004		2005		2006		MTO LS - 618
MDA, CA	1.03	2.03	1.04	2.04	1.05	2.05	1.06	2.06	
Mean	19.18	19.07	10.53	10.53	11.49	11.43	5.6	5.4	5.0
1S	1.01	0.95	0.53	0.53	0.61	0.72	0.38	0.35	0.5
D2S	2.85	2.68	1.51	1.51	1.73	2.04	1.08	0.98	1.4
n/Outliers	62/1		58/4		61/4		58/3		

Test 17	2003		2004		2005		2006		MTO LS - 614
Freeze-thaw	1.03	2.03	1.04	2.04	1.05	2.05	1.06	2.06	
Mean	15.93	16.06	17.46	17.65	14.59	14.77	12.68	13.22	19
1S	3.44	2.95	3.72	3.77	2.95	3.16	1.38	2.00	1.7
D2S	9.73	8.36	10.53	10.68	8.31	8.92	3.91	5.67	4.9
n/Outliers	45/3		47/1		47/3		44/4		

A – AMRL reports percent passing inch series equivalent sieves.

σ' - Calculated from Coefficient of Variation Precision Statement (Coefficient of Variation = Standard Deviation / Mean)

Test 20	2003		2004		2005		2006		ASTM C136[A]
P 2.36 mm	3.03	4.03	3.04	4.04	3.05	4.05	3.06	4.06	
Mean	42.4	43.1	37.2	36.4	37.4	36.2	45.4	45.3	60 - 20
1S	1.9	2.1	1.9	2.1	1.7	1.8	1.7	1.6	1.41
D2S	5.3	5.8	5.6	5.8	4.9	5.0	4.8	4.5	4.0
n/Outliers	202/2		202/2		205/1		202/6		

Test 21	2003		2004		2005		2006		ASTM C136[A]
P 1.18 mm	3.03	4.03	3.04	4.04	3.05	4.05	3.06	4.06	
Mean	30.8	32.1	28.4	27.9	25.7	25.0	36.5	36.5	60 - 20
1S	2.1	2.0	1.9	2.0	1.5	1.7	2.1	1.9	1.41
D2S	5.9	5.7	5.3	5.6	4.3	4.9	5.9	5.5	4.0
n/Outliers	202/2		202/2		205/1		206/2		

Test 22	2003		2004		2005		2006		ASTM C136[A]
P 600 µm	3.03	4.03	3.04	4.04	3.05	4.05	3.06	4.06	
Mean	22.7	24.2	19.7	19.4	17.0	16.6	28.2	28.2	60 - 20
1S	1.8	1.7	1.5	1.7	1.1	1.3	1.8	1.9	1.41
D2S	5.0	4.9	4.3	4.9	3.2	3.7	5.2	5.3	4.0
n/Outliers	202/2		203/1		204/2		207/1		

Test 23	2003		2004		2005		2006		ASTM C136[A]
P 300 µm	3.03	4.03	3.04	4.04	3.05	4.05	3.06	4.06	
Mean	17.1	18.2	12.2	12.0	11.9	11.6	19.0	19.1	20 - 15
1S	1.3	1.2	1.1	1.2	0.8	0.9	1.3	1.4	1.01
D2S	3.8	3.5	3.0	3.5	2.4	2.7	3.6	3.9	3.10
n/Outliers	201/3		204/0		204/2		207/1		

Test 24	2003		2004		2005		2006		ASTM C136[A]
P 150 µm	3.03	4.03	3.04	4.04	3.05	4.05	3.06	4.06	
Mean	12.6	13.3	8.3	8.1	9.4	9.2	12.0	12.2	15 - 10
1S	0.9	0.8	0.7	0.9	0.7	0.7	0.8	0.8	0.73
D2S	2.6	2.3	2.1	2.6	1.9	1.9	2.3	2.4	2.1
n/Outliers	200/4		203/1		202/4		205/3		

Test 25	2003		2004		2005		2006		ASTM C136[A]
P 75 µm	3.03	4.03	3.04	4.04	3.05	4.05	3.06	4.06	
Mean	9.2	9.6	6.3	6.1	7.8	7.6	7.7	7.8	10 – 2
1S	0.6	0.6	0.6	0.7	0.6	0.6	0.6	0.6	0.65
D2S	1.7	1.7	1.7	2.1	1.7	1.7	1.6	1.6	1.8
n/Outliers	200/4		202/2		203/3		202/6		

Test 27	2003		2004		2005		2006		ASTM C 128
RD (O.D)	3.03	4.03	3.04	4.04	3.05	4.05	3.06	4.06	
Mean	2.654	2.656	2.602	2.600	2.593	2.501	2.665	2.615	
1S	0.012	0.012	0.015	0.019	0.017	0.045	0.015	0.038	0.023
D2S	0.034	0.034	0.042	0.054	0.048	0.127	0.042	0.107	0.066
n/Outliers	77/10		82/11		87/8		90/10		

Test 28	2003		2004		2005		2006		ASTM C 128
ABS	3.03	4.03	3.04	4.04	3.05	4.05	3.06	4.06	
Mean	0.85	0.82	1.717	1.719	1.713	3.109	0.746	1.502	< 1.0%
1S	0.20	0.15	0.19	0.30	0.30	0.78	0.13	0.49	0.23
D2S	0.58	0.43	0.56	0.85	0.86	2.20	0.37	1.38	0.66
n/Outliers	78/9		83/10		91/4		88/12		

A – AMRL reports percent passing inch series equivalent sieves.

σ^{*} - Calculated from Coefficient of Variation Precision Statement (Coefficient of Variation = Standard Deviation / Mean)

Test 29	2003		2004		2005		2006		ASTM C88
MgSO4	3.03	4.03	3.04	4.04	3.05	4.05	3.06	4.06	
Mean	14.4	14.1	11.9	11.9	17.3	17.0	11.7	11.7	ASTM precision
1S	4.4	4.6	4.5	4.5	3.6	3.9	3.4	3.2	Statements for
D2S	12.6	13.0	12.9	12.9	10.0	10.9	9.6	9.0	Coarse
n/Outliers	32/0		33/0		29/2		31/0		Aggregate only

Test 30	2003		2004		2005		2006		MTO LS-621
% ACP	1.03	2.03	1.04	2.04	1.05	2.05	1.06	2.06	
Mean	39.3	38.9	41.3	40.6	39.4	40.1	39.7	39.9	No MTO
1S	5.2	4.7	4.9	4.4	3.6	3.1	4.7	4.7	Precision
D2S	14.7	13.3	14.0	12.6	10.2	8.8	13.2	13.3	statements for
n/Outliers	195/5		196/6		188/14		206/1		this test

Test 31	2003		2004		2005		2006		MTO LS-623
MWD	3.03	4.03	3.04	4.04	3.05	4.05	3.06	4.06	
Mean	2.409	2.407	2.280	2.281	2.308	2.306	2.271	2.272	No MTO
1S	0.044	0.051	0.029	0.041	0.037	0.040	0.031	0.030	precision
D2S	0.124	0.144	0.082	0.116	0.104	0.112	0.088	0.085	statements for
n/Outliers	134/4		133/8		143/4		147/4		this test

Test 32	2003		2004		2005		2006		MTO LS-623
MDD	3.03	4.03	3.04	4.04	3.05	4.05	3.06	4.06	
Mean	2.252	2.251	2.102	2.105	2.134	2.133	2.093	2.095	No MTO
1S	0.049	0.052	0.033	0.040	0.045	0.051	0.038	0.041	precision
D2S	0.138	0.147	0.093	0.113	0.127	0.144	0.107	0.116	statements for
n/Outliers	134/4		136/5		147/0		149/2		this test

Test 33	2003		2004		2005		2006		MTO LS-623
OMC	3.03	4.03	3.04	4.04	3.05	4.05	3.06	4.06	
Mean	7.13	7.15	8.47	8.48	8.16	8.20	8.55	8.48	No MTO
1S	0.44	0.45	0.45	0.49	0.47	0.52	0.50	0.61	precision
D2S	1.25	1.28	1.28	1.39	1.33	1.46	1.41	1.72	statements for
n/Outliers	136/2		141/0		144/3		147/4		this test

Test 34	2003		2004		2005		2006		MTO LS-619
MDA, FA3	3.03	4.03	3.04	4.04	3.05	4.05	3.06	4.06	
Mean	15.1	15.1	16.6	16.7	15.3	15.4	11.6	11.7	10.5
1S	1.1	1.1	1.5	1.4	1.1	1.1	0.9	0.8	0.63
D2S	3.2	3.0	4.1	4.1	2.3	3.1	2.7	2.4	1.78
n/Outliers	61/3		61/1		62/3		60/2		

Test 40	2003		2004		2005		2006		MTO LS-702
P 2.0 mm	5.03	6.03	5.04	6.04	5.05	6.05	5.06	6.06	
Mean	100.0	100.0	100.0	100.0	99.9	99.9	100.0	99.9	No MTO
1S									precision
D2S									statements for
n/Outliers	57/8		67/0		67/0		68/0		this test

Test 41	2003		2004		2005		2006		MTO LS-702
P 425 µm	5.03	6.03	5.04	6.04	5.05	6.05	5.06	6.06	
Mean	98.3	98.3	97.1	97.0	96.5	96.5	96.9	96.9	No MTO
1S	0.5	0.4	0.6	0.6	0.3	0.4	0.5	0.5	precision
D2S	1.4	1.1	1.7	1.7	1.0	1.1	1.6	1.4	statements for
n/Outliers	61/4		60/7		59/8		61/7		this test

Ā – AMRL reports percent passing inch series equivalent sieves.

σ' - Calculated from Coefficient of Variation Precision Statement (Coefficient of Variation = Standard Deviation / Mean)

Test 42	2003		2004		2005		2006		MTO LS-702
P 75 µm	5.03	6.03	5.04	6.04	5.05	6.05	5.06	6.06	
Mean	92.5	92.5	91.7	91.7	88.7	88.8	91.7	91.5	No MTO
1S	0.9	0.8	0.9	0.8	0.6	0.5	0.8	0.8	precision
D2S	2.5	2.2	2.7	2.4	1.6	1.5	2.3	2.2	statements for
n/Outliers	59/6		59/8		63/4		60/8		this test

Test 43	2003		2004		2005		2006		MTO LS-702
P 20 µm	5.03	6.03	5.04	6.04	5.05	6.05	5.06	6.06	
Mean	63.5	62.3	78.1	78.5	71.0	70.3	78.1	78.9	No MTO
1S	5.4	4.3	3.3	3.8	4.8	4.1	6.0	4.5	precision
D2S	15.3	12.3	9.5	10.8	13.6	11.6	17.1	12.8	statements for
n/Outliers	61/4		60/7		65/2		61/7		this test

Test 44	2003		2004		2005		2006		MTO LS-702
P 5 µm	5.03	6.03	5.04	6.04	5.05	6.05	5.06	6.06	
Mean	45.8	45.1	59.0	58.8	44.0	43.8	59.2	58.9	No MTO
1S	4.1	4.1	4.3	3.8	3.7	3.3	2.7	2.9	precision
D2S	11.7	11.6	12.1	10.7	10.6	9.3	7.8	8.1	statements for
n/Outliers	62/3		62/5		64/3		58/10		this test

Test 45	2003		2004		2005		2006		MTO LS-702
P 2 µm	5.03	6.03	5.04	6.04	5.05	6.05	5.06	6.06	
Mean	35.4	34.7	44.4	44.6	30.5	30.5	44.4	44.6	No MTO
1S	4.5	4.3	2.8	2.7	3.1	3.0	3.1	3.1	precision
D2S	12.9	12.1	7.9	7.7	8.8	8.6	8.9	8.8	statements for
n/Outliers	63/2		57/10		65/2		61/7		this test

Test 46	2003		2004		2005		2006		ASTM D 4318
L. L	5.03	6.03	5.04	6.04	5.05	6.05	5.06	6.06	
Mean	34.0	33.8	36.9	37.2	27.7	27.6	37.1	36.9	33.3
1S	2.2	1.9	1.8	1.7	1.4	1.5	1.9	1.9	0.8
D2S	6.3	5.5	5.0	4.9	4.0	4.1	5.3	5.4	2
n/Outliers	77/1		75/2		73/4		77/1		

Test 47	2003		2004		2005		2006		ASTM D 4318
P. L	5.03	6.03	5.04	6.04	5.05	6.05	5.06	6.06	
Mean	17.6	17.6	19.3	19.2	15.6	15.5	19.2	19.0	19.9
1S	1.92	1.78	1.4	1.4	1.3	1.5	1.6	1.6	1.3
D2S	5.4	5.0	3.9	4.0	3.7	4.4	4.4	4.4	4
n/Outliers	77/1		74/3		75/2		74/4		

Test 48	2003		2004		2005		2006		ASTM D 4318
P. I	5.03	6.03	5.04	6.04	5.05	6.05	5.06	6.06	
Mean	16.1	16.0	17.5	18.0	12.3	12.3	17.9	18.0	13.4
1S	2.71	2.67	2.1	2.3	1.7	1.8	1.7	1.9	1.6
D2S	7.66	7.56	6.1	6.4	4.7	5.2	4.7	5.6	4
n/Outliers	78/0		76/1		77/0		75/3		

Test 49	2003		2004		2005		2006		AASHTO T 100
SG of Soils	5.03	6.03	5.04	6.04	5.05	6.05	5.06	6.06	
Mean	2.703	2.699	2.729	2.733	2.729	2.728	2.733	2.730	
1S	0.041	0.042	0.029	0.029	0.027	0.030	0.030	0.031	0.04
D2S	0.116	0.118	0.082	0.082	0.076	0.085	0.085	0.088	0.11
n/Outliers	58/0		50/10		52/6		52/4		

A – AMRL reports percent passing inch series equivalent sieves.

σ^{*} - Calculated from Coefficient of Variation Precision Statement (Coefficient of Variation = Standard Deviation / Mean)

Test 95	2003		2004		2005		2006		ASTM C 1252
UC Void	3.03	4.03	3.04	4.04	3.05	4.05	3.06	4.06	
Mean	41.64	42.12	42.09	41.81	41.19	40.33	43.13	42.06	ASTM C 1252[A]
1S	1.62	1.35	1.48	1.11	1.45	1.39	0.68	1.08	0.33%
D2S	4.58	3.83	4.19	3.15	4.08	3.91	1.93	3.06	0.93%
n/Outliers	28/4		35/6		50/1		50/5		

Test 96	2003		2004		2005		2006		ASTM D 2419
SE Value	3.03	4.03	3.04	4.04	3.05	4.05	3.06	4.06	
Mean	31.15	31.19	49.9	50.6	30.7	30.0	56.4	55.9	< 80
1S	3.51	2.80	8.08	8.60	3.74	2.82	5.76	5.91	8.0
D2S	9.93	7.92	22.88	24.30	10.54	7.95	16.3	16.72	22.6
n/Outliers	28/1		38/0		42/7		53/0		

Test 97	2003		2004		2005		2006		ASTM D 5821
% Fractured	1.03	2.03	1.04	2.04	1.05	2.05	1.06	2.06	
Mean	66.12	67.07	71.18	71.51	71.28	70.54	75.7	76.1	76.0%
1S	6.78	6.65	5.02	5.01	5.02	5.24	3.9	4.7	5.2%
D2S	19.19	18.82	14.20	14.18	14.17	14.77	11.21	13.31	14.7%
n/Outliers	32/1		42/0		53/0		54/3		

Test 99	2003		2004		2005		2006		AST D 4791
% F & E	1.03	2.03	1.04	2.04	1.05	2.05	1.06	2.06	
Mean	0.46	0.38	1.75	1.61	1.14	1.18	2.68	2.25	No ASTM
1S	0.52	0.42	1.12	0.93	0.69	0.67	1.36	1.16	precision
D2S	1.47	1.19	3.13	2.64	1.94	1.89	3.86	3.27	statements for
n/Outliers	32/2		40/2		46/7		55/1		this test

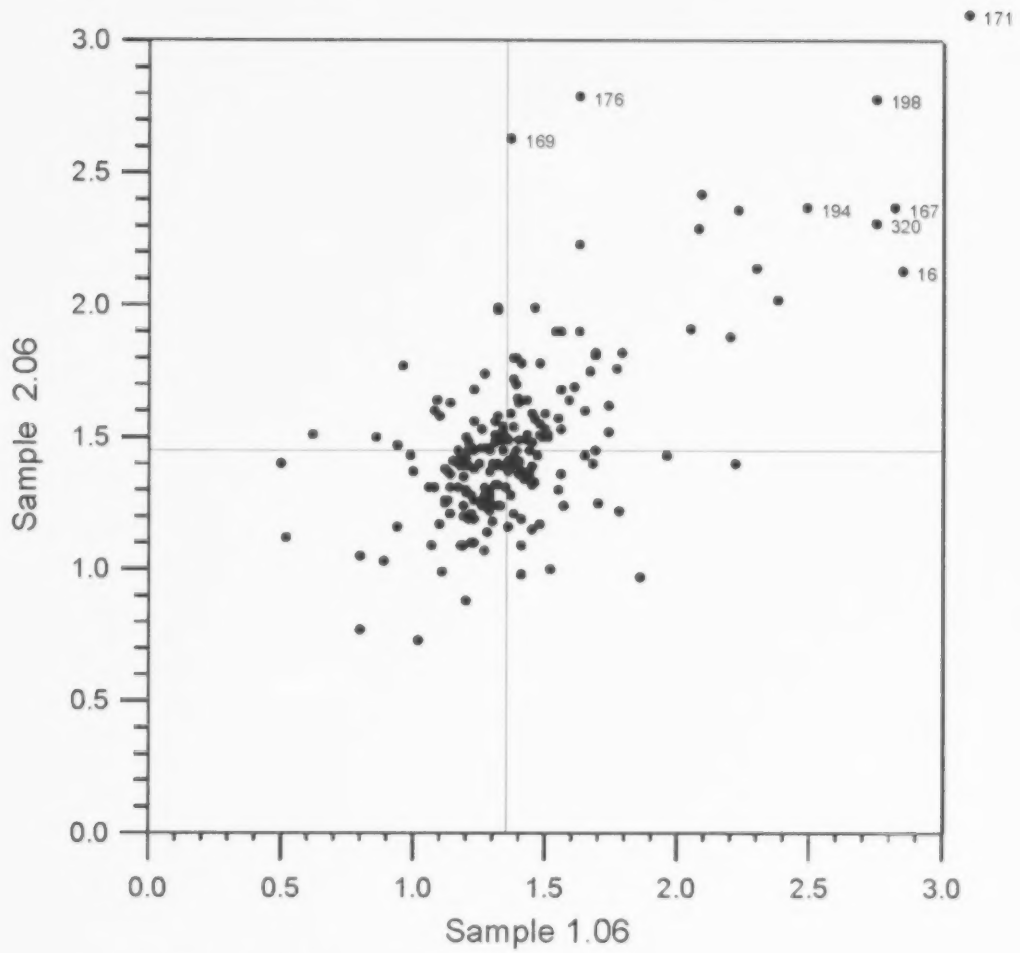
Test 123	2004		2005		2006		2007		ASTM C 1260
Mortar Bar	1.04	2.04	1.05	2.05	1.06	2.06	1.07	2.07	
Mean	0.196	0.410	Not						Expansion>0.1%
1S	0.035	0.051	Conducted						15.2%
D2S	0.099	0.144							43 %
n/Outliers	16/0								

A – AMRL reports percent passing inch series equivalent sieves.

σ - Calculated from Coefficient of Variation Precision Statement (Coefficient of Variation = Standard Deviation / Mean)

Appendix D1: Scatter Diagrams

2006 MTO AGGREGATE AND SOIL
PROFICIENCY SAMPLE TESTING PROGRAM

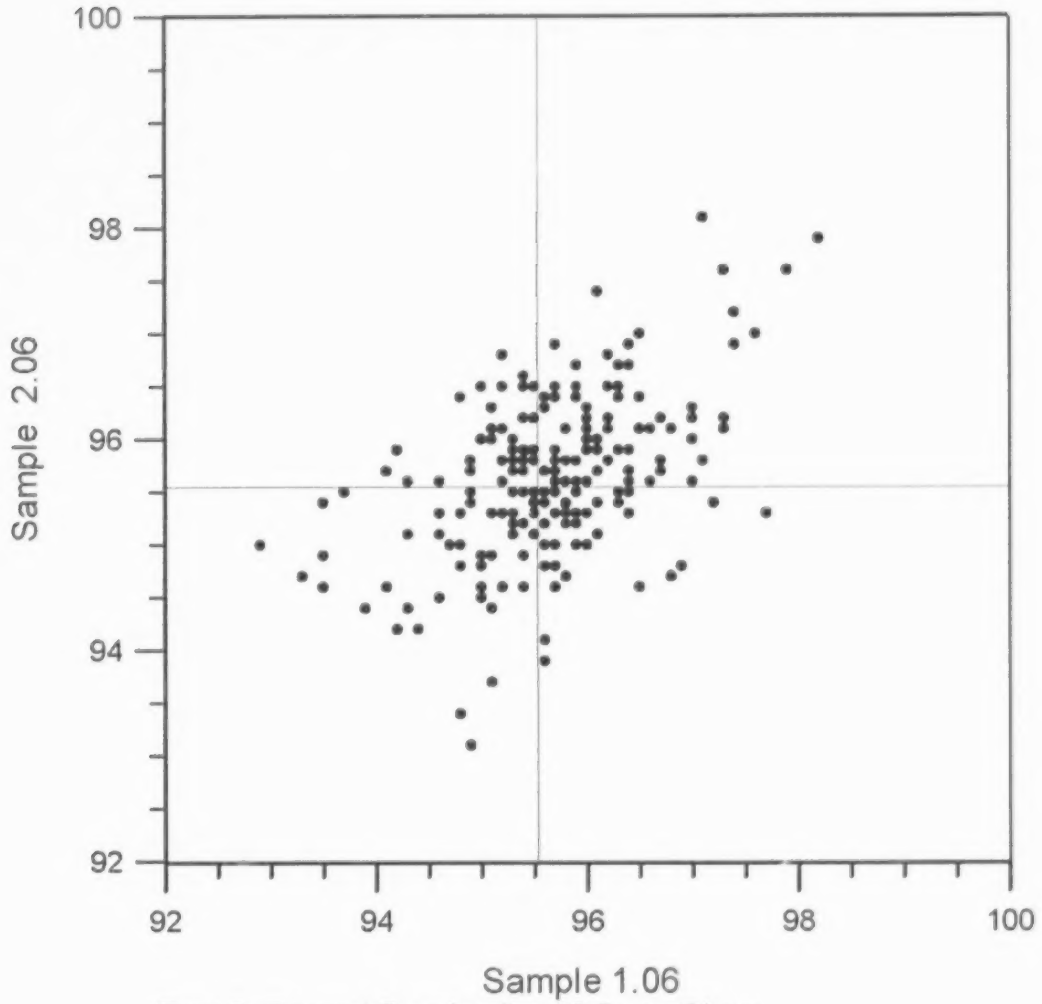


Test 1: Wash Pass 75 um

	Mat 1	Mat 2
Mean	1.359	1.456
Median	1.440	1.575
Std Dev	0.273	0.286
n = 200		

Labs Eliminated: 16, 167, 169, 171, 176, 194, 198, 320

2006 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

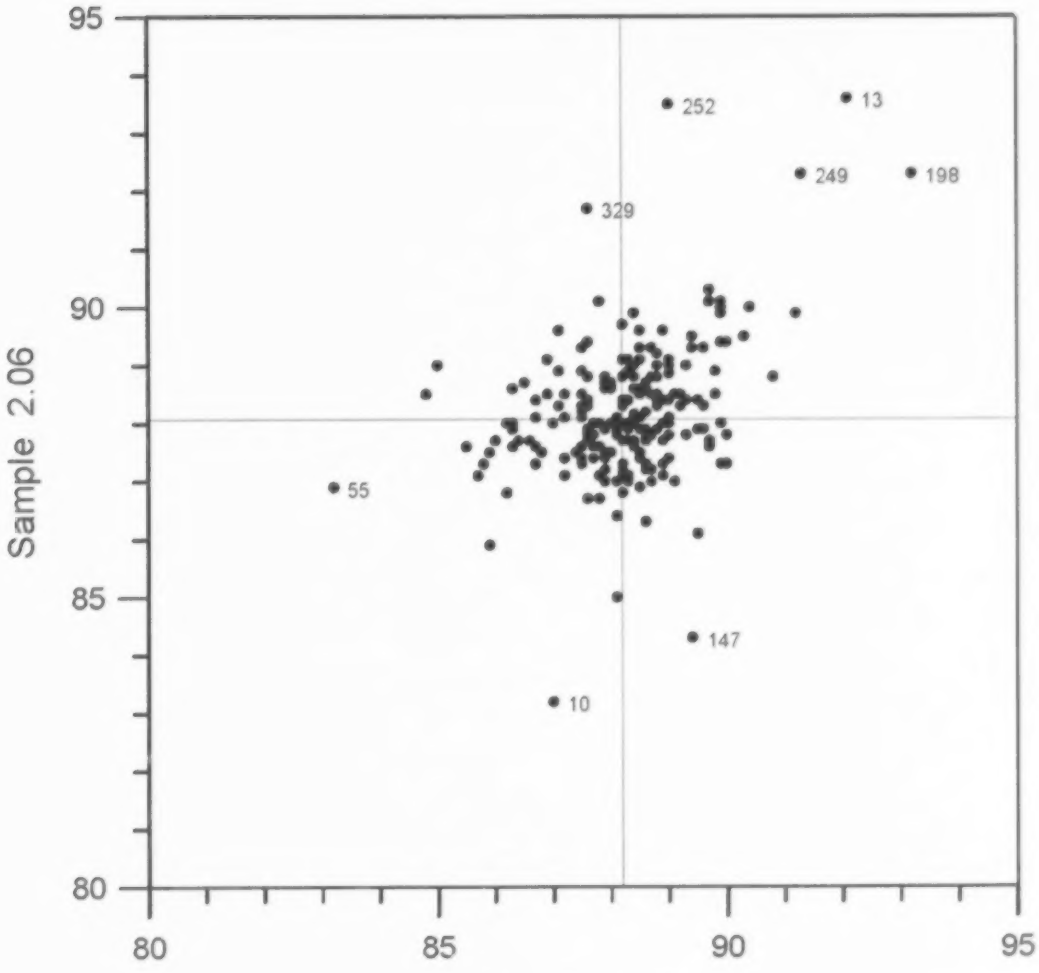


Test 2: Percent Passing the 19.0 mm Sieve

	Mat 1	Mat 2
Mean	95.647	95.619
Median	95.550	95.600
Std Dev	0.841	0.763
n = 208		

Lab Eliminated: None

2006 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

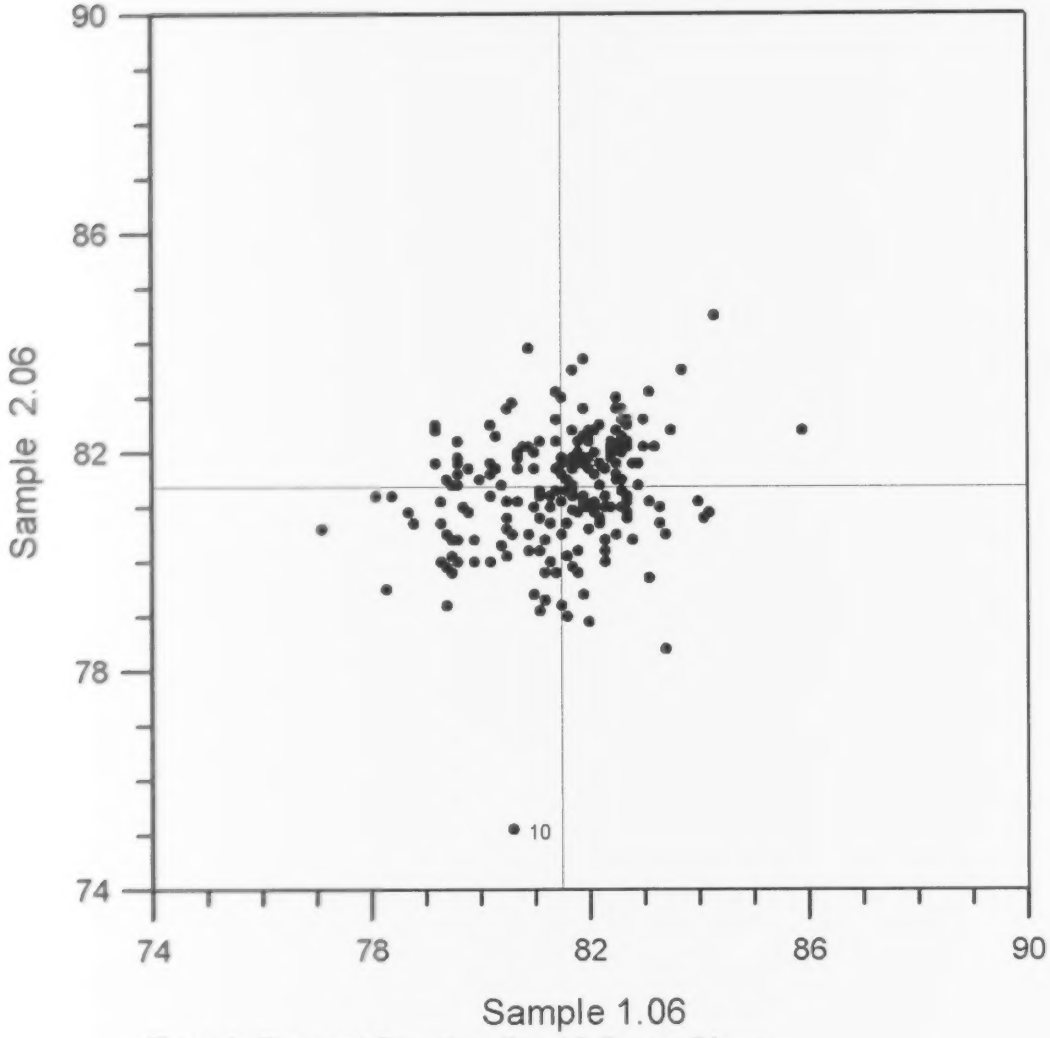


Test 3: Percent Passing the 16.0 mm Sieve

	Mat 1	Mat 2
Mean	88.254	88.140
Median	88.000	87.650
Std Dev	1.138	0.871
n = 200		

Lab Eliminated: 10, 13, 55, 147, 198, 249, 252, 329

2006 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

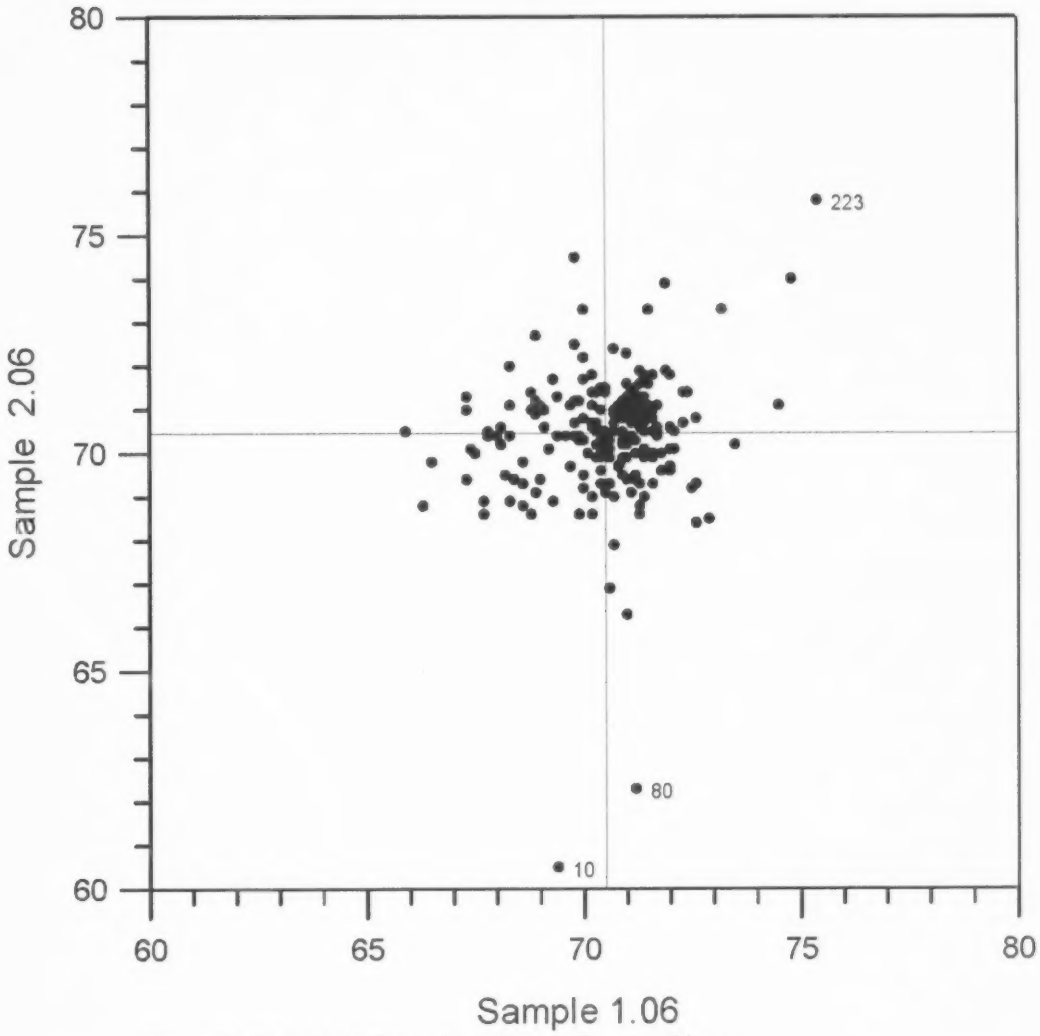


Test 4: Percent Passing the 13.2 mm Sieve

	Mat 1	Mat 2
Mean	81.479	81.346
Median	81.500	81.450
Std Dev	1.288	1.001
n = 207		

Lab Eliminated: 10

2006 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

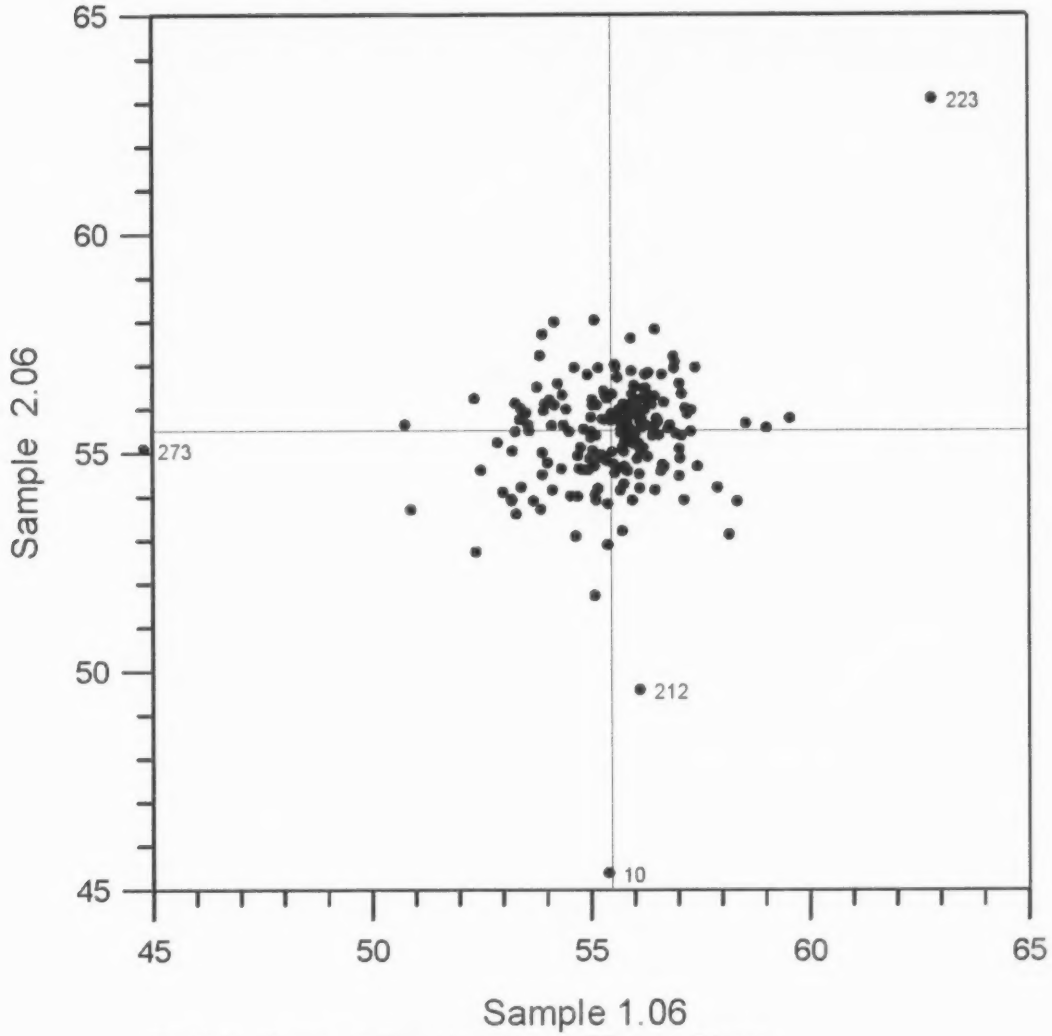


Test 5: Percent Passing the 9.5 mm Sieve

	Mat 1	Mat 2
Mean	70.533	70.502
Median	70.350	70.400
Std Dev	1.419	1.123
n = 205		

Labs Eliminated: 10, 80, 223

2006 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

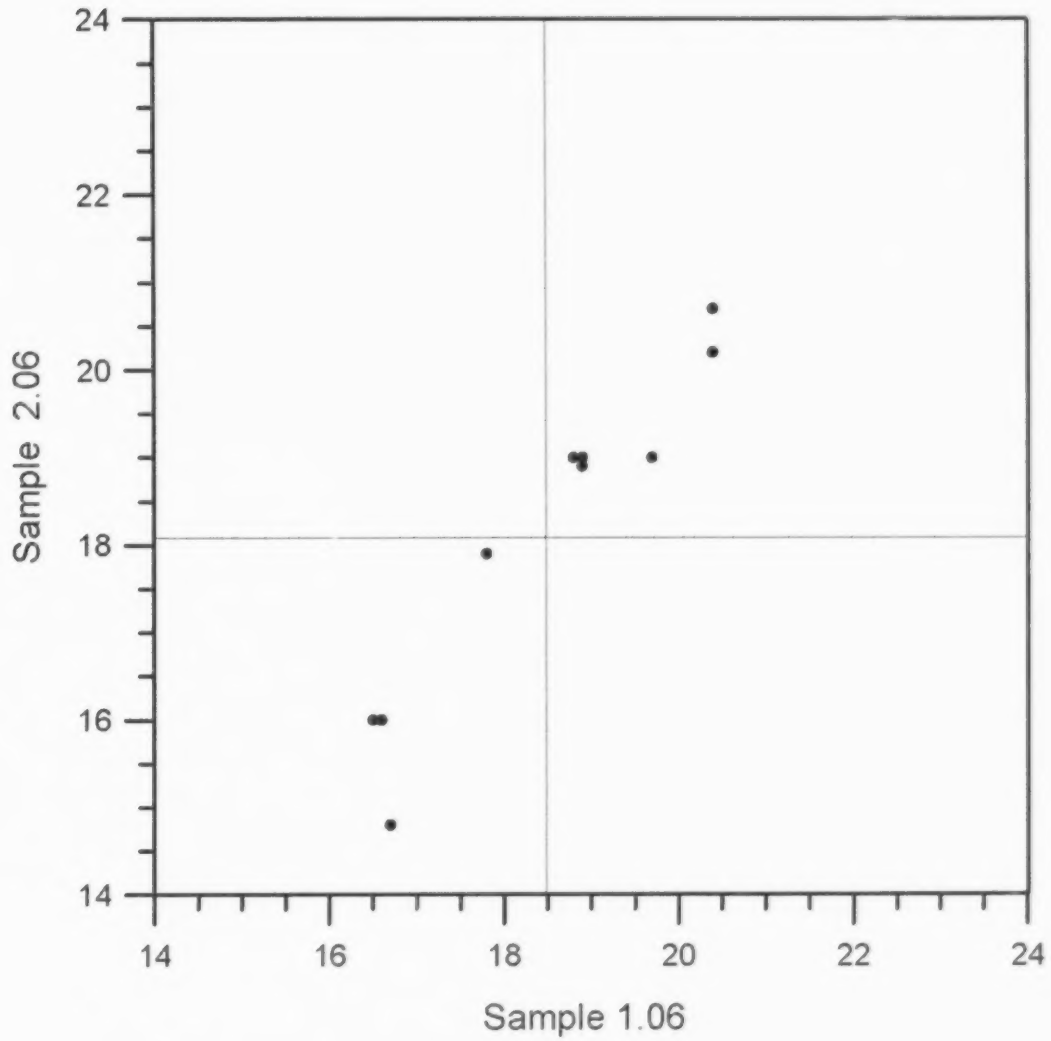


Test 6: Percent Passing the 4.75 mm Sieve

	Mat 1	Mat 2
Mean	55.512	55.468
Median	55.165	54.880
Std Dev	1.278	1.005
n = 204		

Lab Eliminated: 10, 212, 223, 273

2006 MTO AGGREGATE AND SOIL
PROFICIENCY SAMPLE TESTING PROGRAM

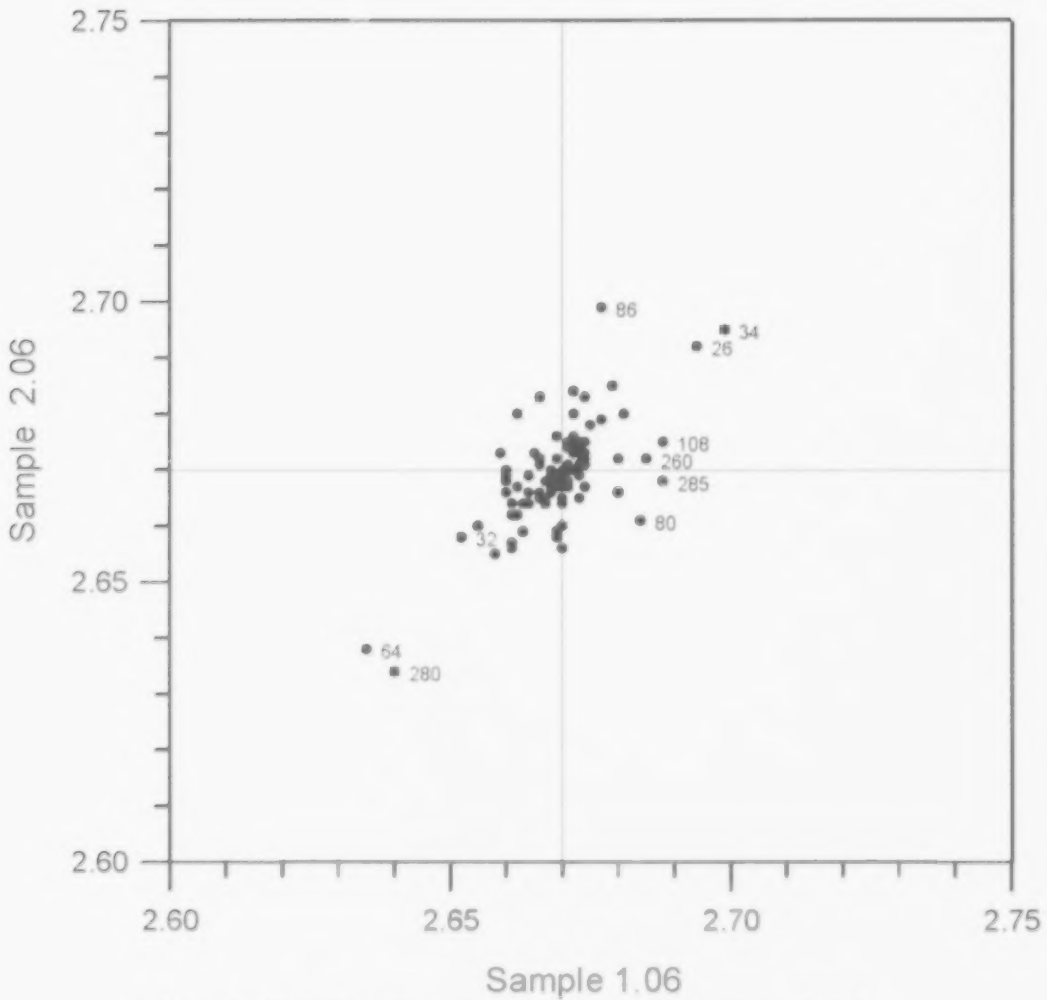


Test 8: Los Angeles Abrasion Loss, %

	Mat 1	Mat 2
Mean	18.470	18.150
Median	18.450	17.750
Std Dev	1.506	1.943
n = 10		

Labs Eliminated: None

2006 MTO AGGREGATE AND SOIL
PROFICIENCY SAMPLE TESTING PROGRAM

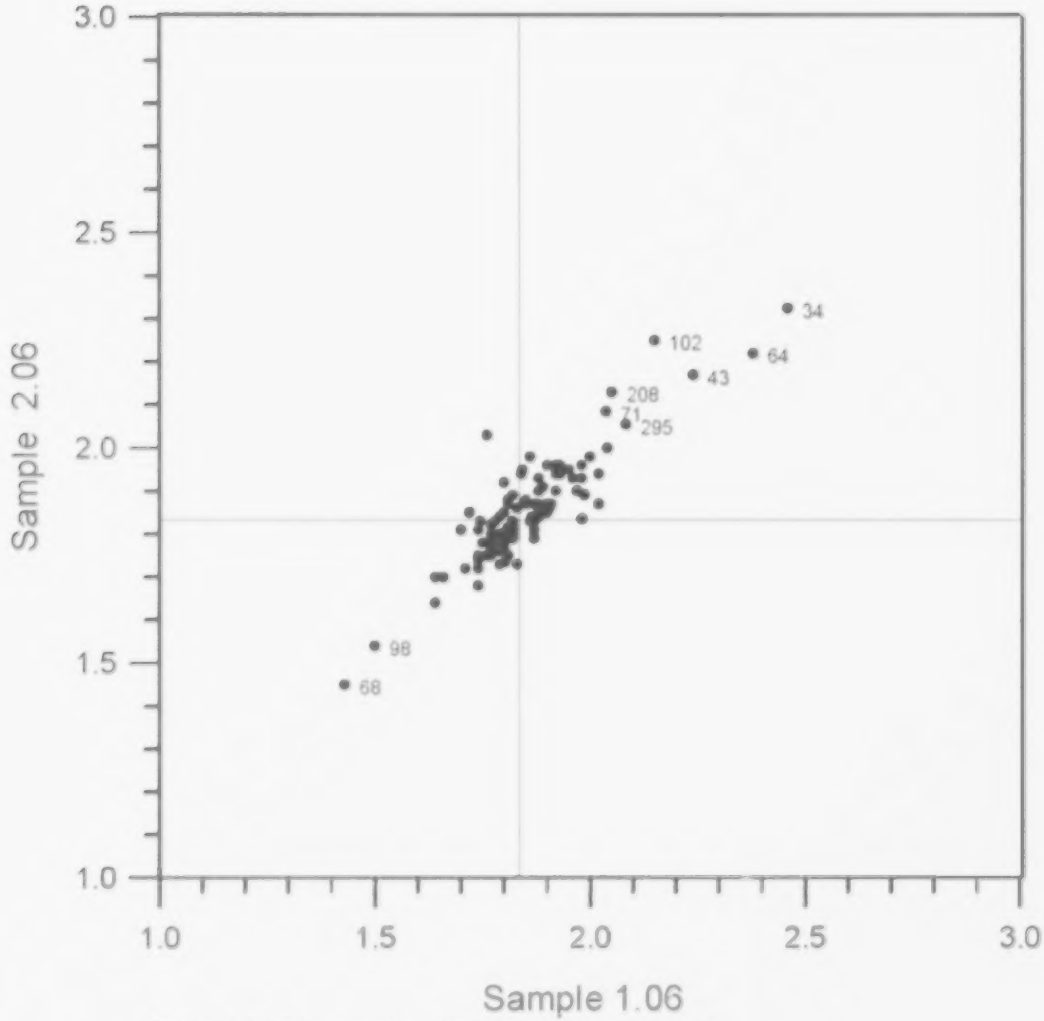


Test 9: Relative Density (Coarse Aggregate - Bulk)

	Mat 1	Mat 2
Mean	2.669	2.669
Median	2.668	2.670
Std Dev	0.005	0.006
n = 91		

Labs Eliminated: 26, 32, 34, 64, 80, 86, 108, 260, 280, 285

2006 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

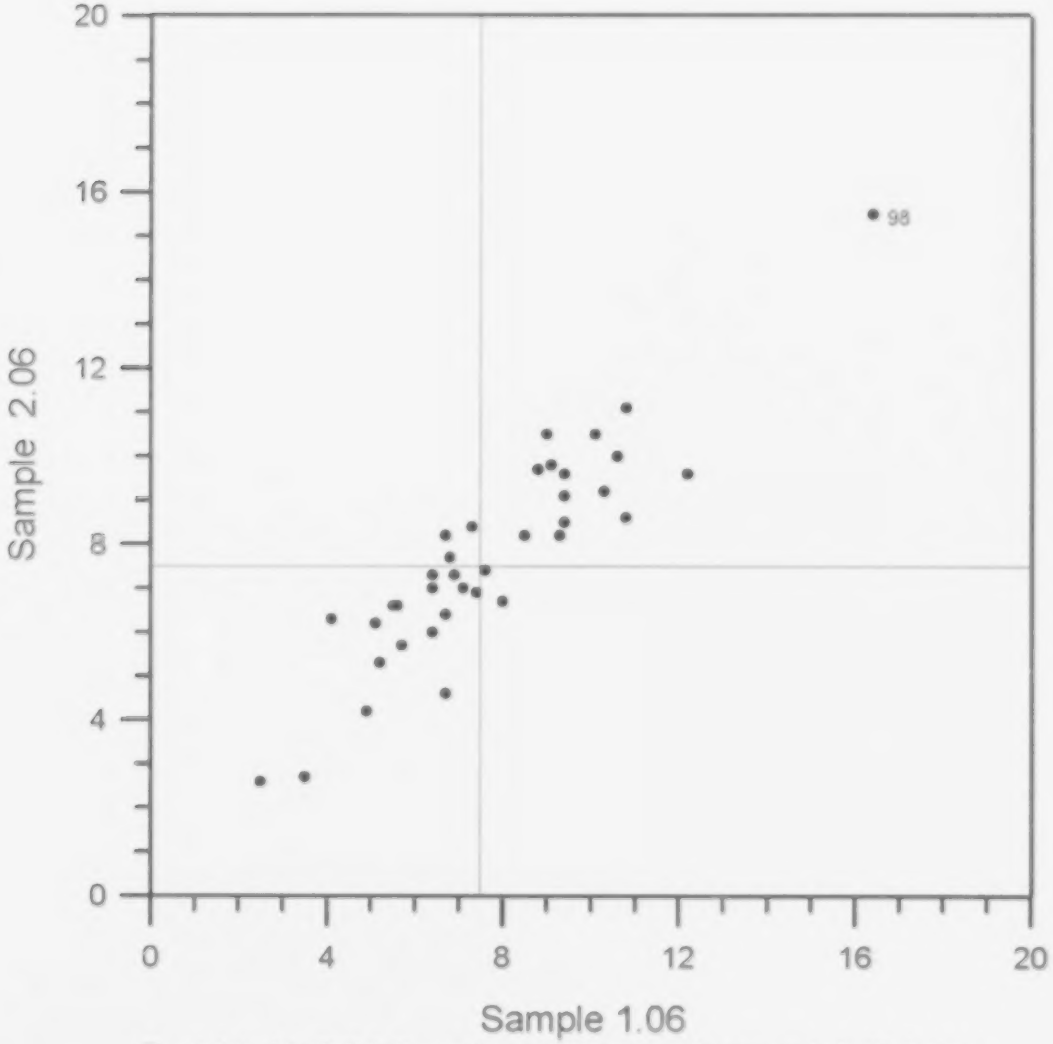


Test 10: Absorption (Coarse Aggregate)

	Mat 1	Mat 2
Mean	1.840	1.835
Median	1.840	1.835
Std Dev	0.093	0.081
n = 92		

Labs Eliminated: 34, 43, 64, 68, 71, 98, 102, 208, 295

2006 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

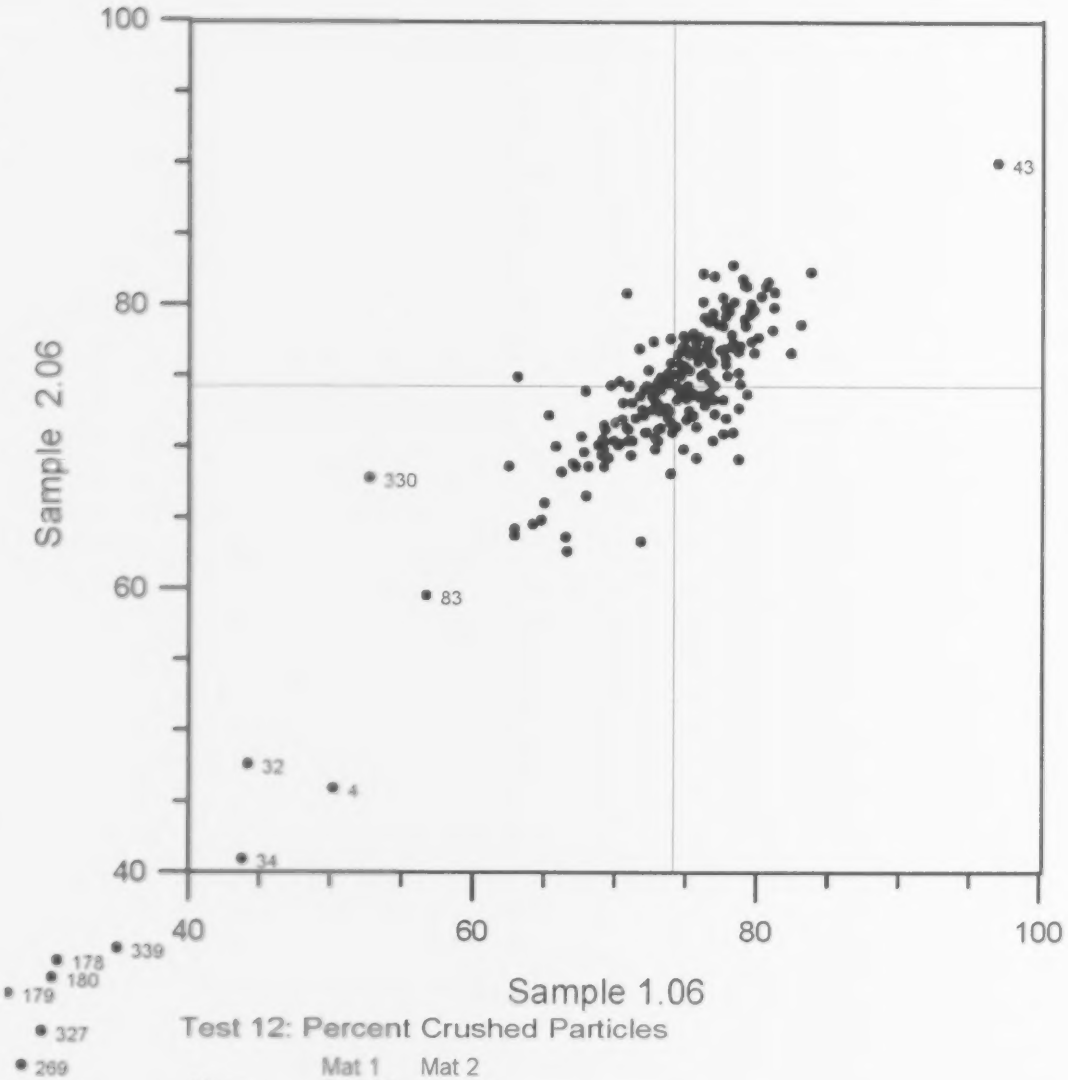


Test 11: MgSO4 Soundness (Coarse Aggregate), % Loss

	Mat 1	Mat 2
Mean	7.506	7.492
Median	7.350	6.850
Std Dev	2.253	2.073
n = 36		

Lab Eliminated: 98

2006 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

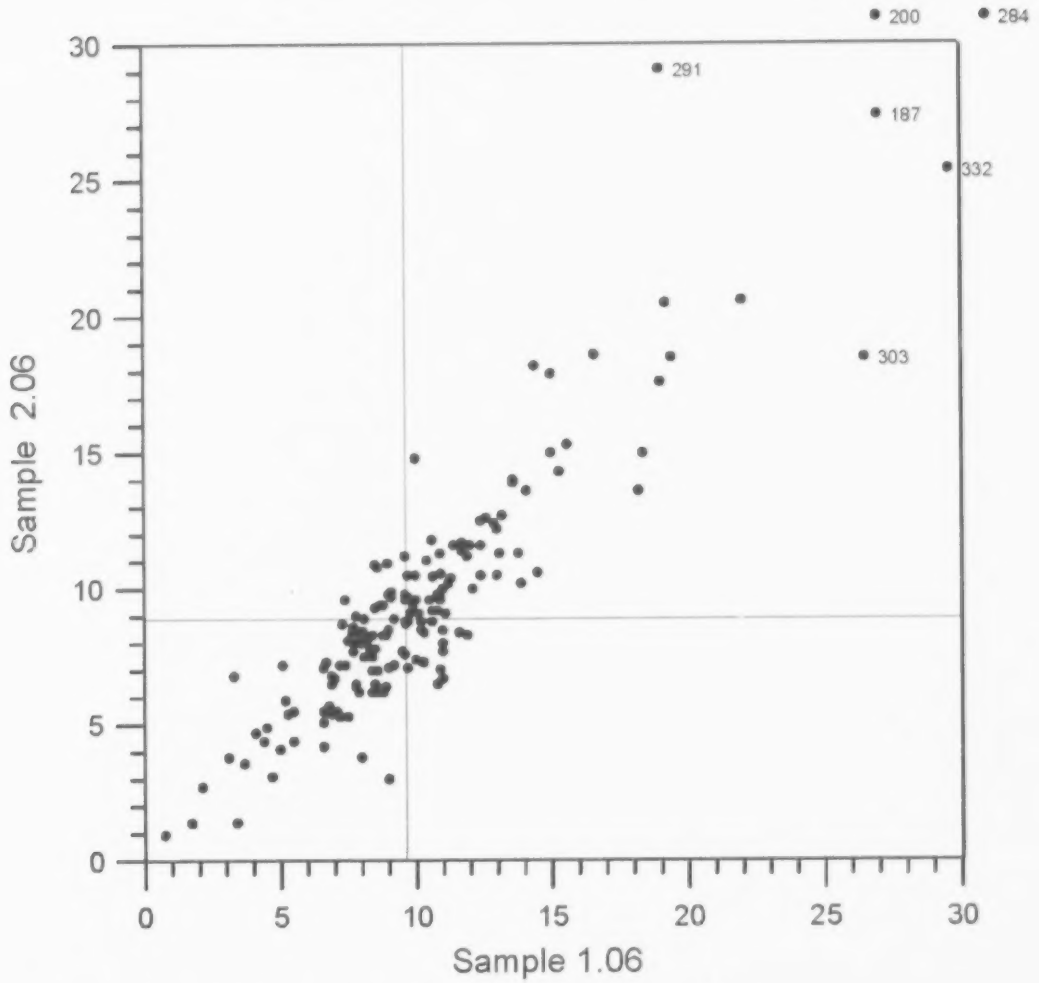


Test 12: Percent Crushed Particles

	Mat 1	Mat 2
Mean	74.260	74.186
Median	73.150	72.700
Std Dev	4.183	4.347
n = 196		

Labs Eliminated: 4, 32, 34, 43, 83, 178, 179, 180, 269, 327, 330, 339

2006 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

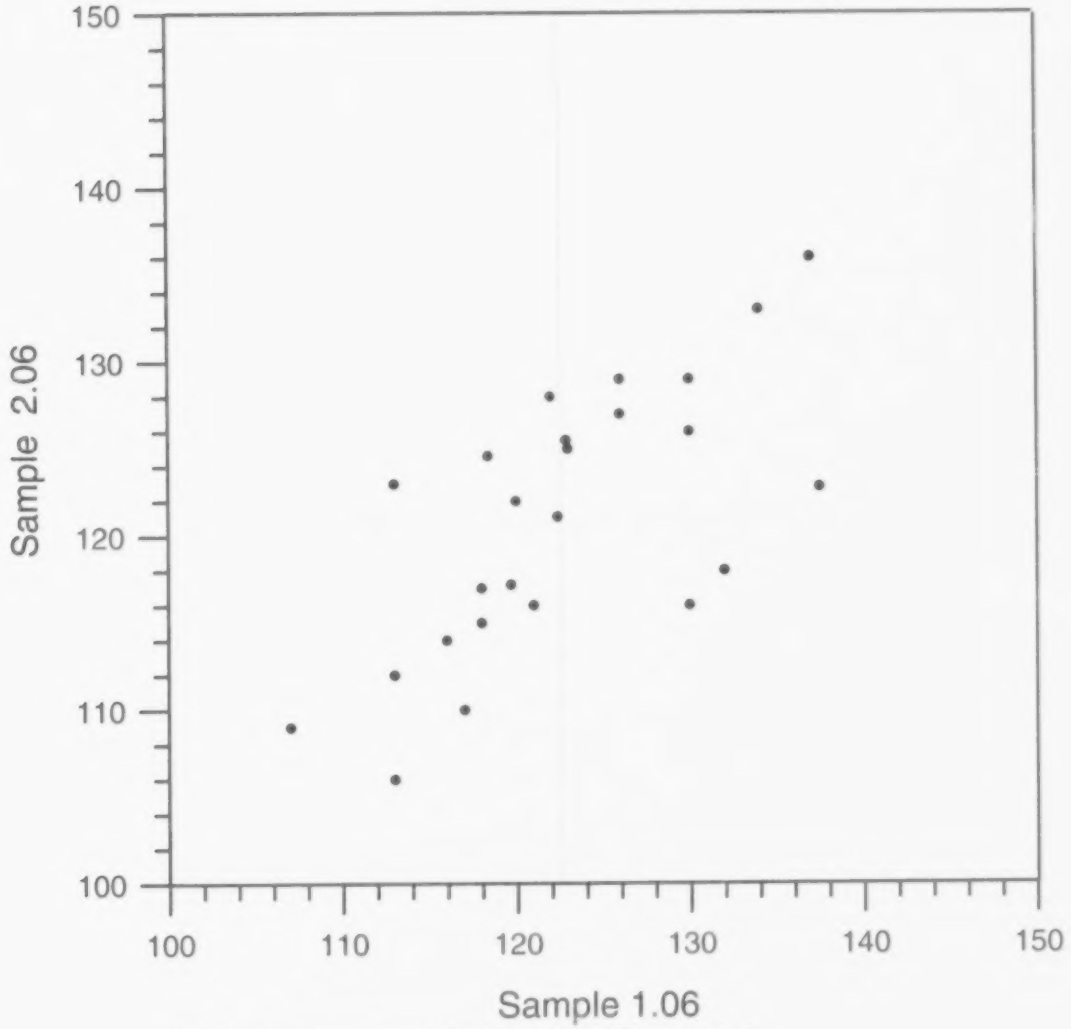


Test 13: Percent Flat and Elongated Particles

	Mat 1	Mat 2
Mean	9.667	8.964
Median	11.372	10.775
Std Dev	3.450	3.542
n = 163		

Labs Eliminated: 187, 200, 284, 291, 303, 332

2006 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

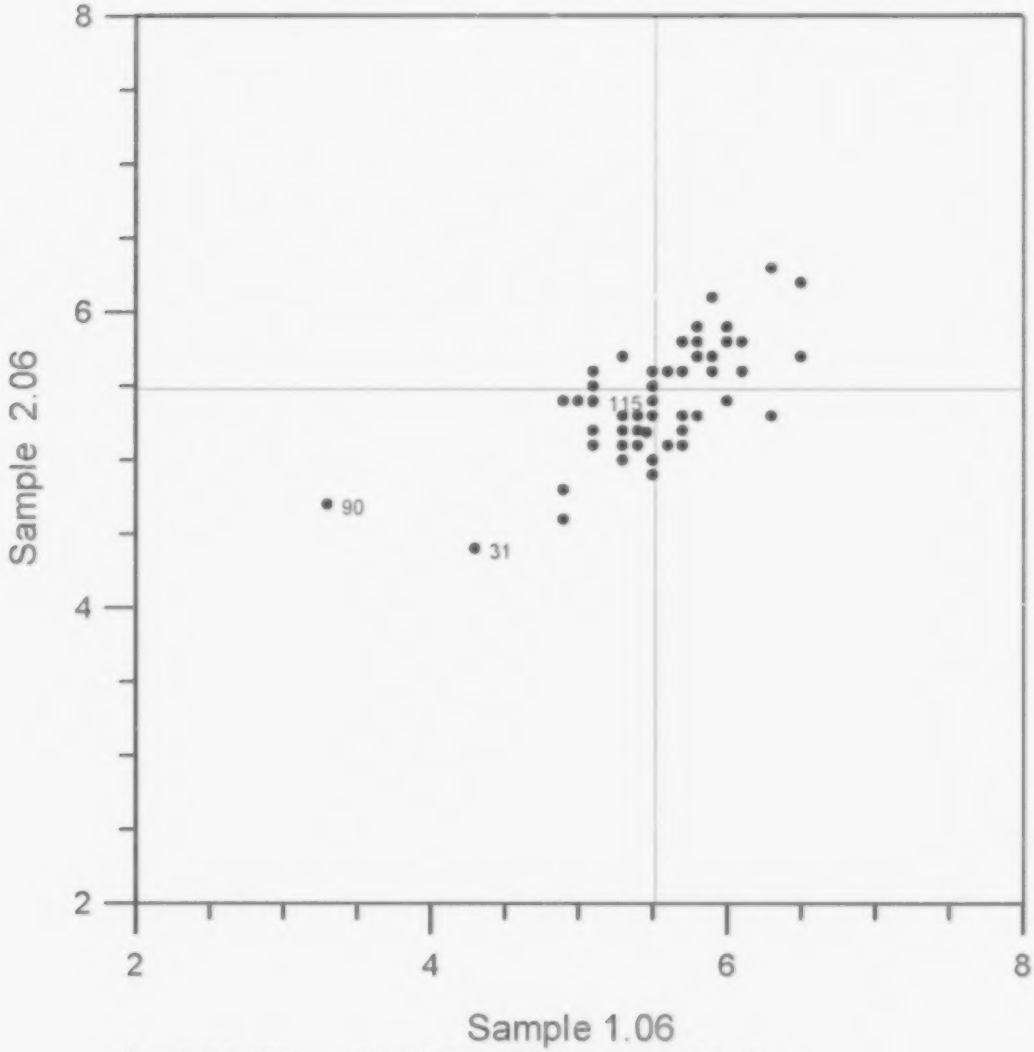


Test 14: Petrographic Number (Concrete)

	Mat 1	Mat 2
Mean	122.7	120.9
Median	122.2	121.0
Std Dev	7.9	7.6
n = 25		

Lab Eliminated: None

2006 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

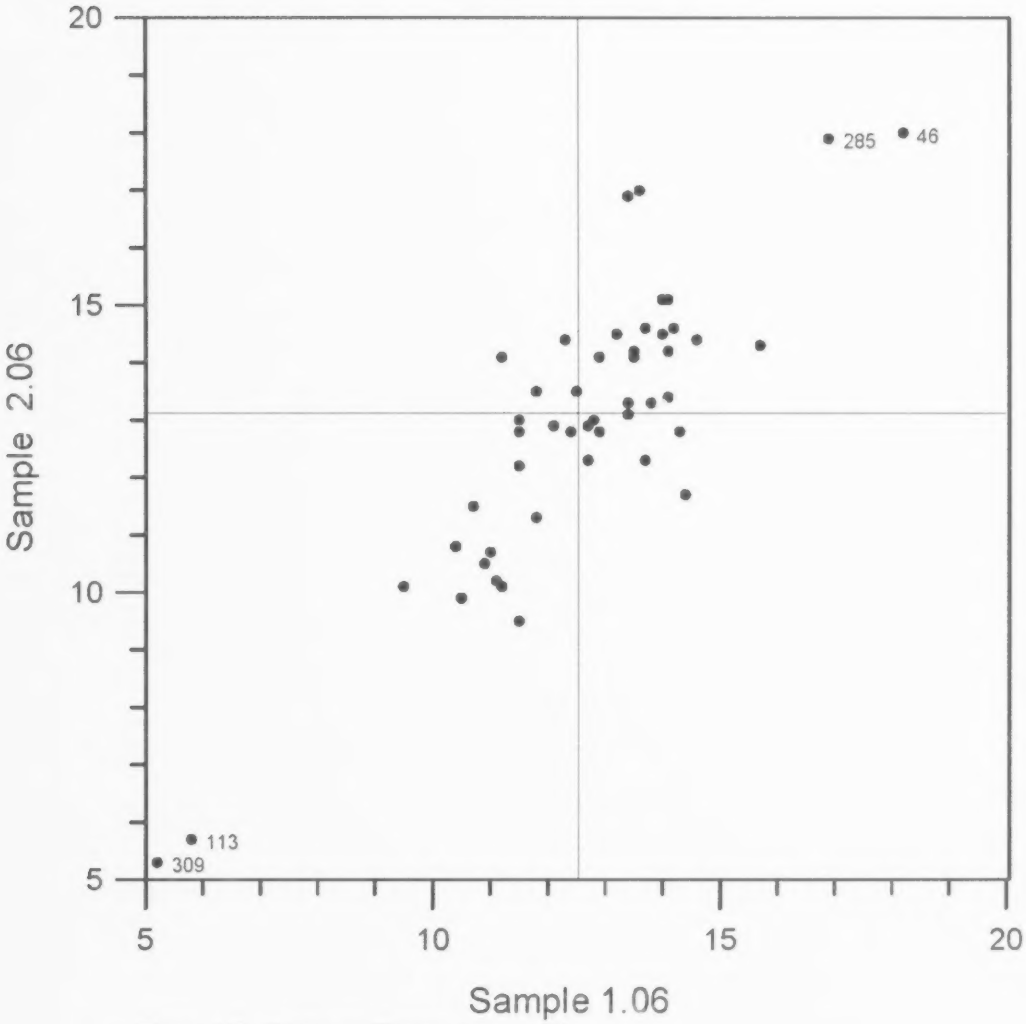


Test 16: Micro-Deval Abrasion Loss (CA), %

	Mat 1	Mat 2
Mean	5.591	5.415
Median	5.700	5.450
Std Dev	0.384	0.346
n = 58		

Labs eliminated: 31, 90, 115

2006 MTO AGGREGATE AND SOIL
PROFICIENCY SAMPLE TESTING PROGRAM

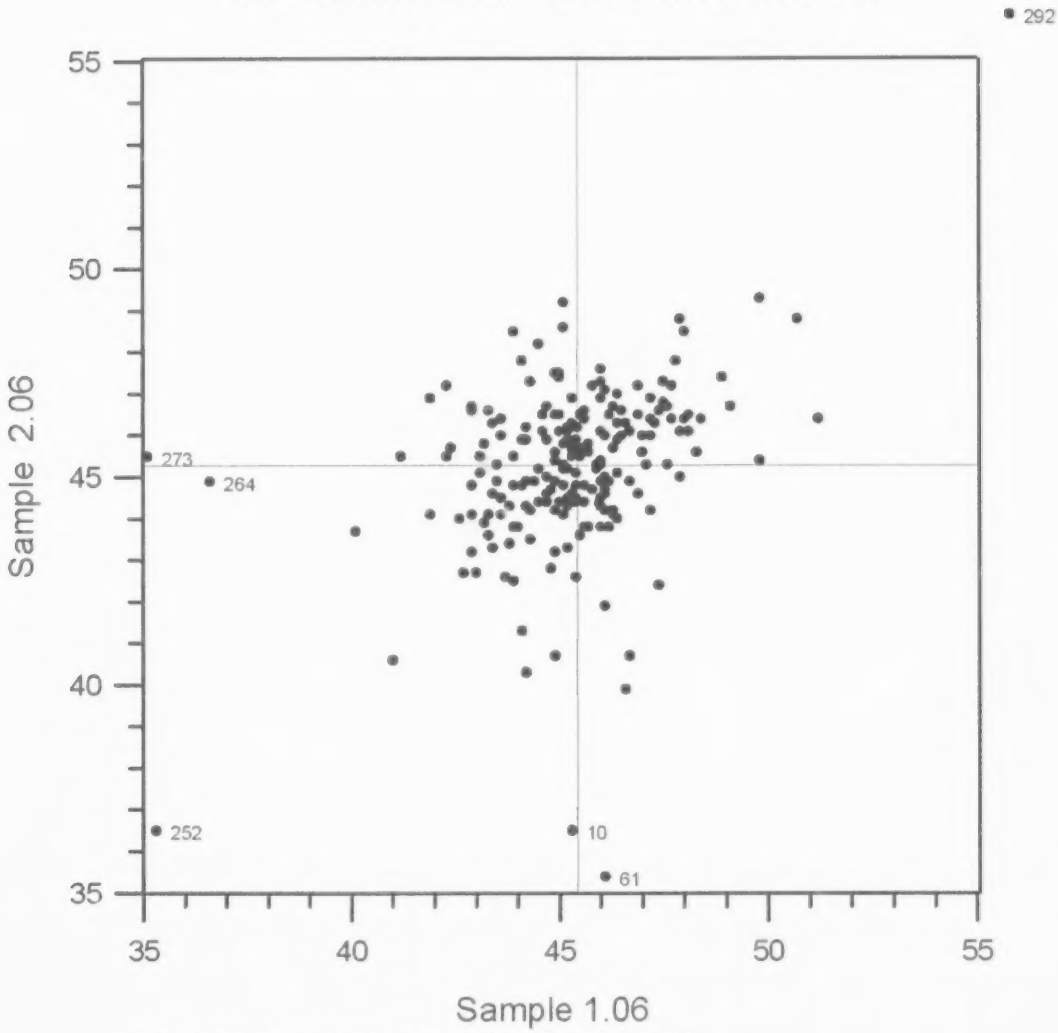


Test 17: Freeze-Thaw Loss, %

	Mat 1	Mat 2
Mean	12.684	13.222
Median	12.600	13.250
Std Dev	1.383	2.005
n = 44		

Lab eliminated: 46, 113, 285, 309

2006 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

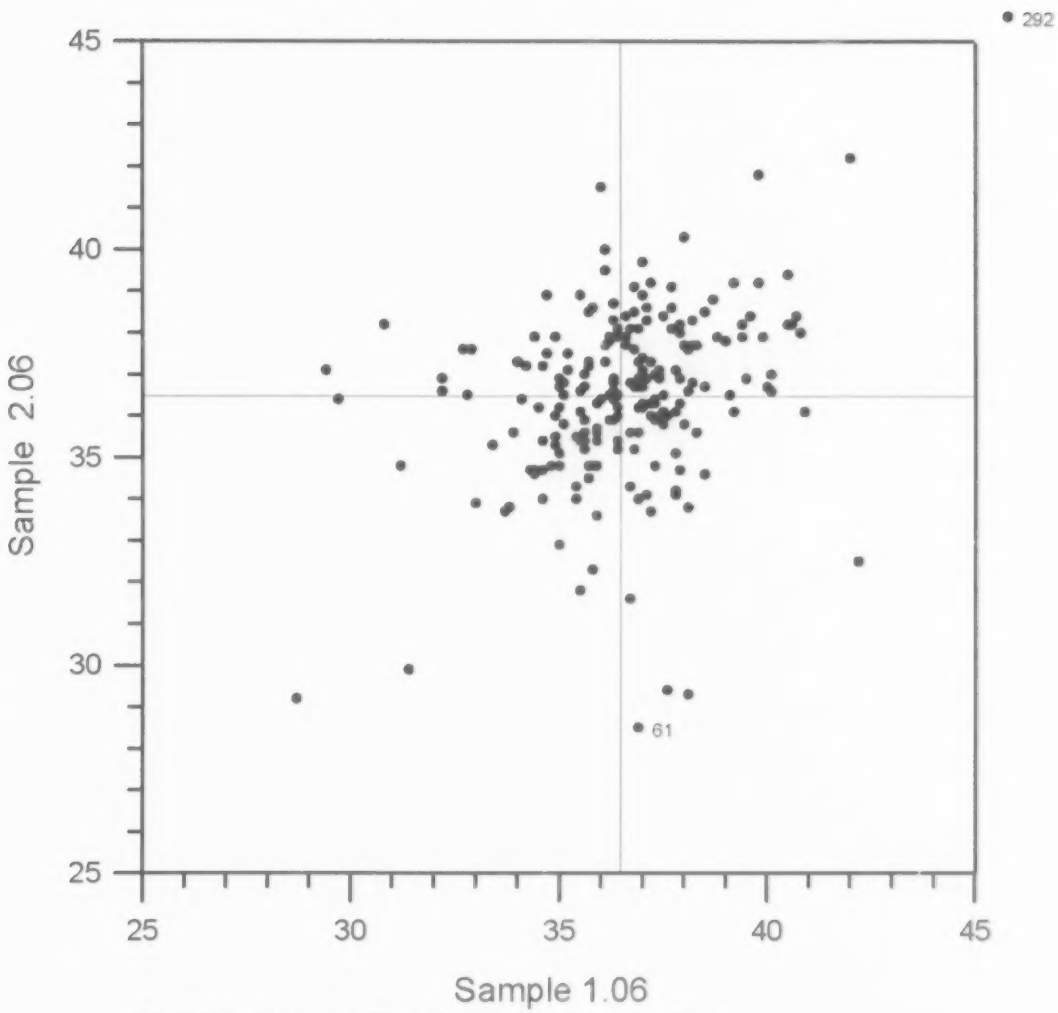


Test 20: Percent Passing the 2.36 mm Sieve

	Mat 1	Mat 2
Mean	45.370	45.331
Median	45.650	44.600
Std Dev	1.694	1.594
n = 202		

Labs Eliminated: 10, 61, 252, 264, 273, 292

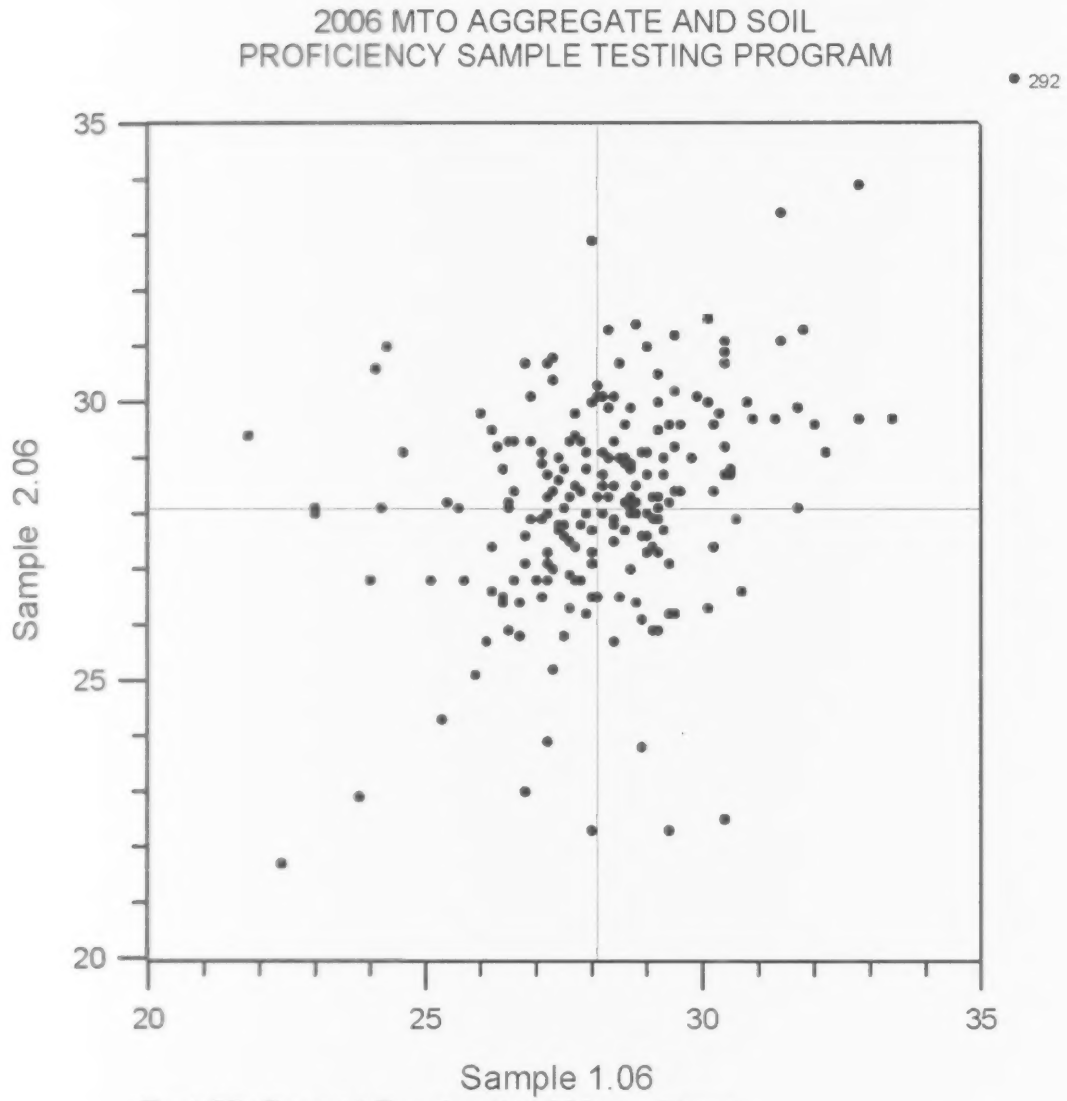
2006 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM



Test 21: Percent Passing the 1.18 mm Sieve

	Mat 1	Mat 2
Mean	36.504	36.491
Median	35.450	35.700
Std Dev	2.080	1.960
n = 206		

Labs Eliminated: 61, 292

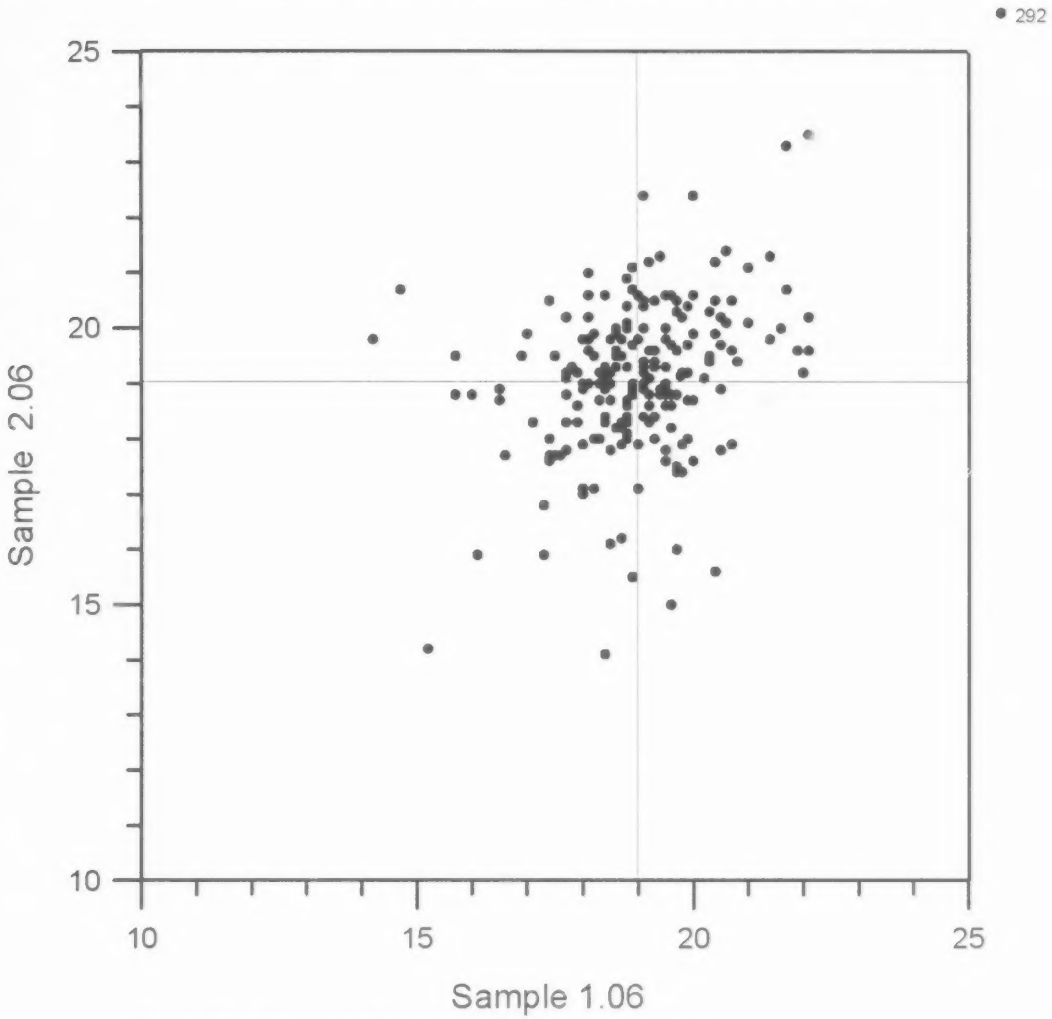


Test 22: Percent Passing the 600 um Sieve

	Mat 1	Mat 2
Mean	28.171	28.236
Median	27.600	27.800
Std Dev	1.827	1.879
n = 207		

Lab Eliminated: 292

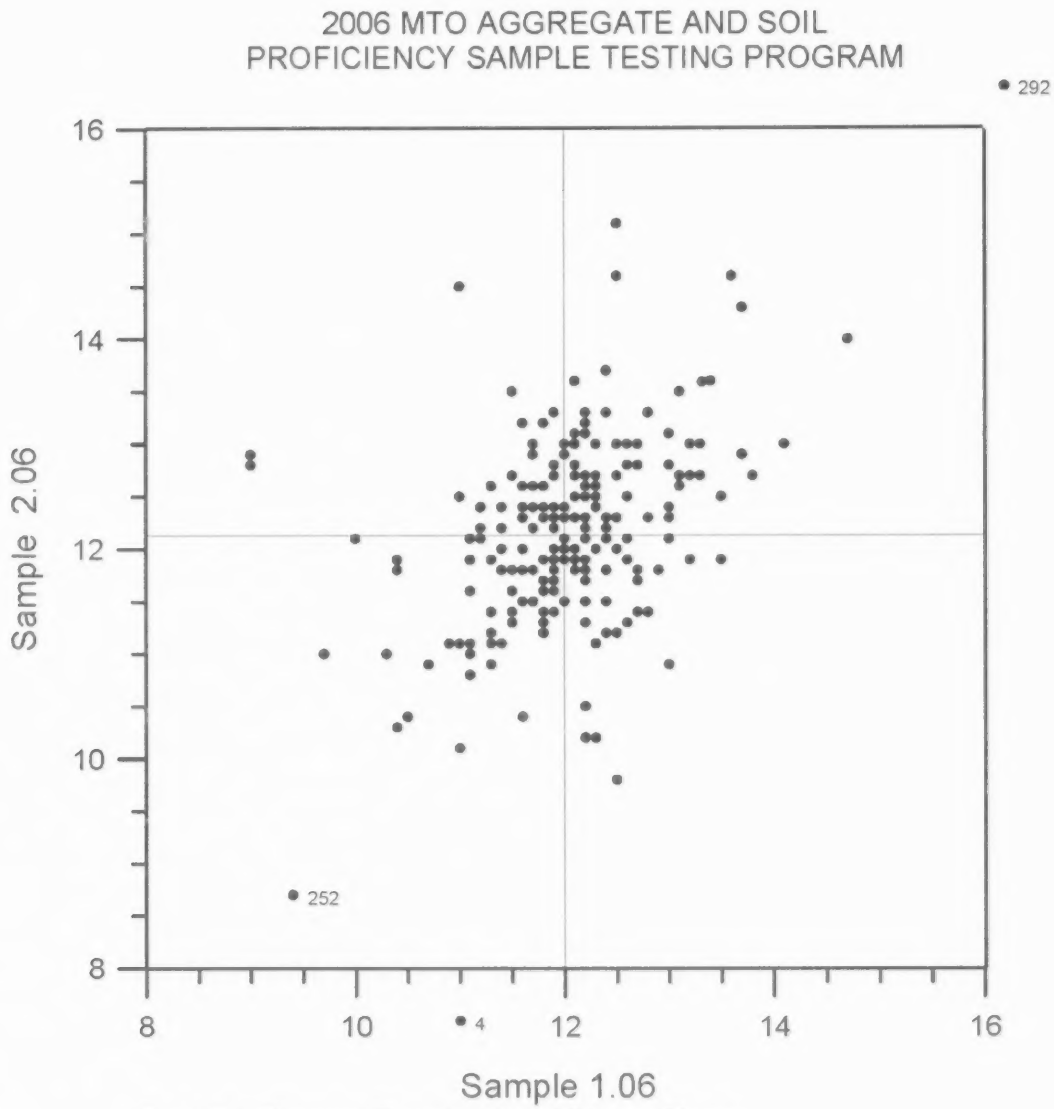
2006 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM



Test 23: Percent Passing the 300 um Sieve

	Mat 1	Mat 2
Mean	18.989	19.091
Median	18.150	18.800
Std Dev	1.284	1.370
n = 207		

Lab Eliminated: 292

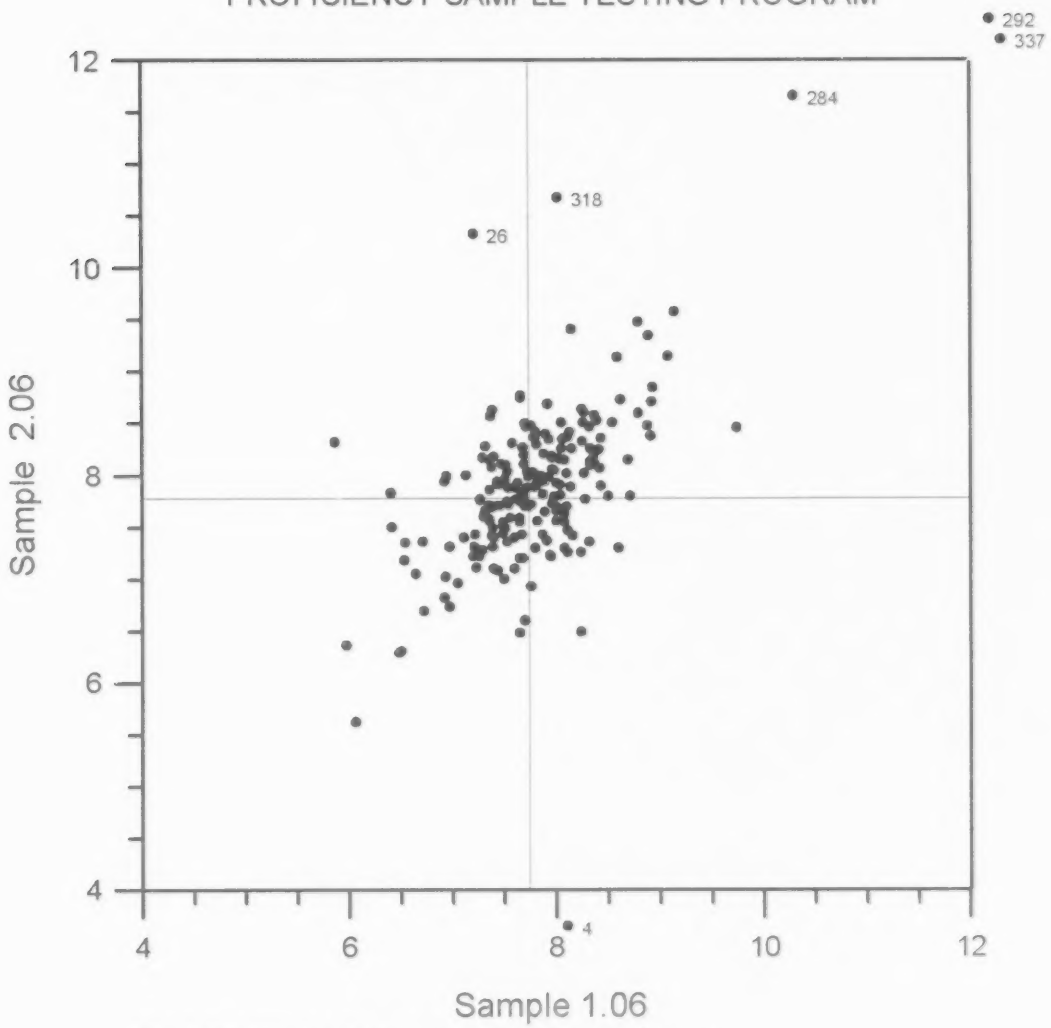


Test 24: Percent Passing the 150 um Sieve

	Mat 1	Mat 2
Mean	12.017	12.180
Median	11.850	12.450
Std Dev	0.818	0.852
n = 205		

Lab Eliminated: 4, 252, 292

2006 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

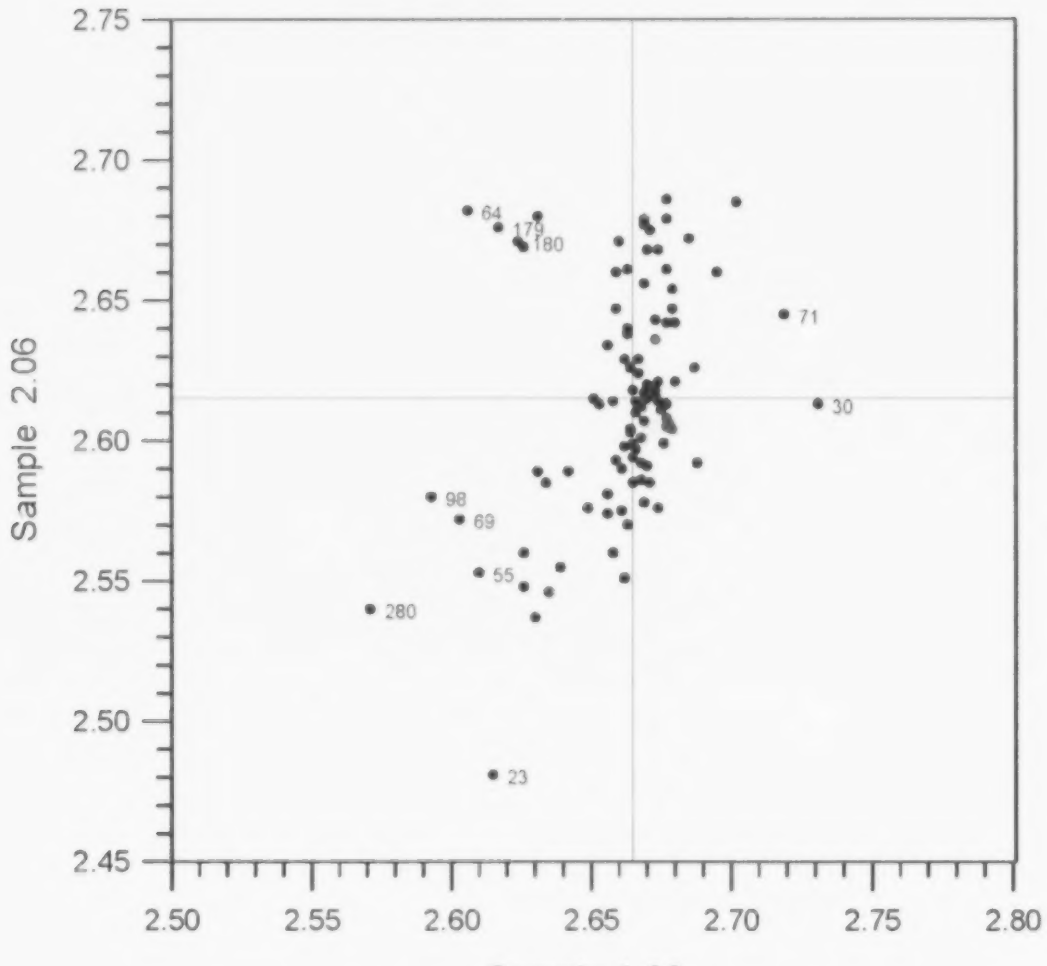


Test 25: Percent Passing the 75 um Sieve

	Mat 1	Mat 2
Mean	7.752	7.842
Median	7.800	7.600
Std Dev	0.576	0.593
n = 202		

Labs Eliminated: 4, 26, 284, 292, 318, 337

2006 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

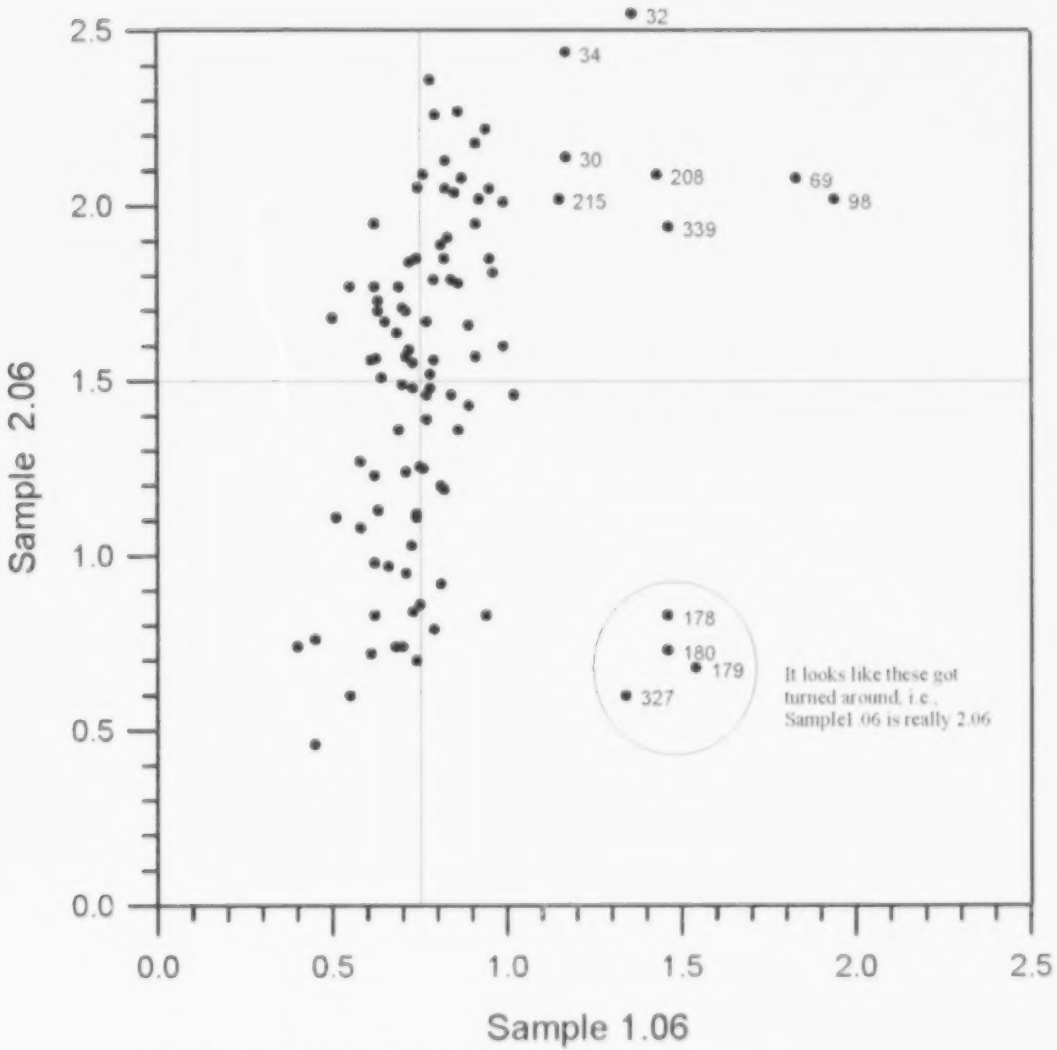


Test 27: Relative Density, (Fine Aggregate - Bulk)

	Mat 1	Mat 2
Mean	2.665	2.616
Median	2.664	2.612
Std Dev	0.015	0.038
n = 90		

Labs Eliminated: 23, 30, 55, 64, 69, 71, 98, 179, 180, 280

2006 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

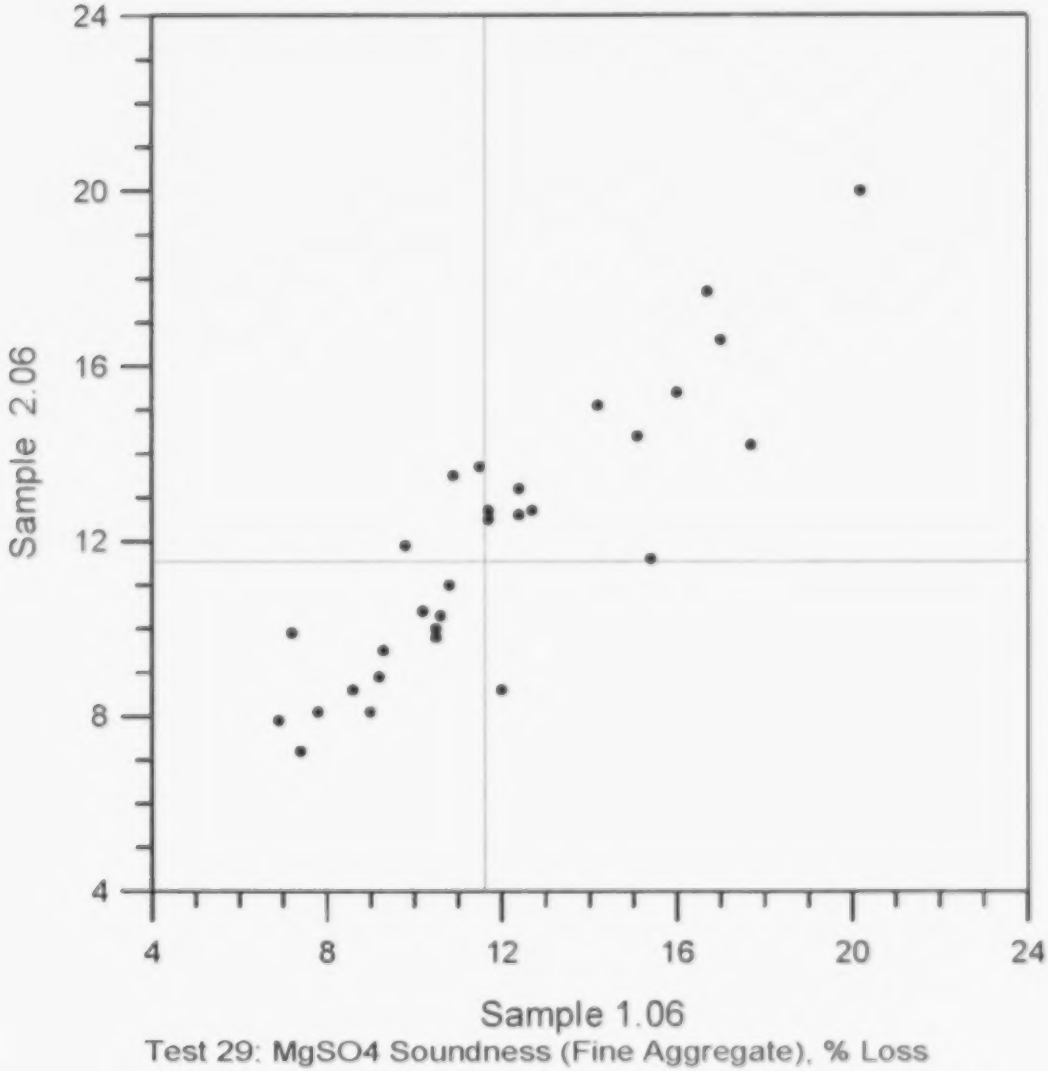


Test 28: Absorption (Fine Aggregate)

	Mat 1	Mat 2
Mean	0.746	1.502
Median	0.710	1.410
Std Dev	0.130	0.489
n = 88		

Labs Eliminated: 30, 32, 34, 69, 98, 178, 179, 180, 208, 215, 327, 339

2006 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

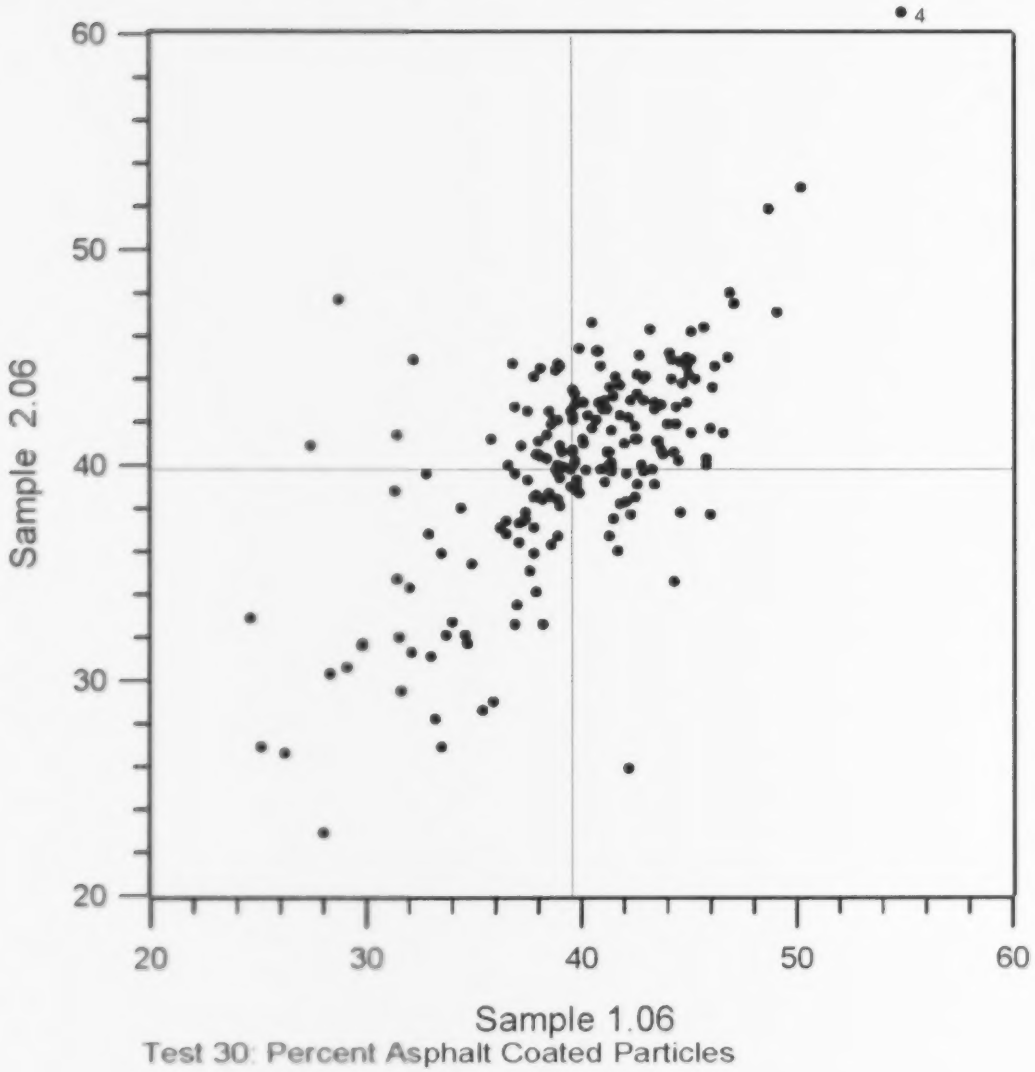


Test 29: MgSO4 Soundness (Fine Aggregate), % Loss

	Mat 1	Mat 2
Mean	11.703	11.719
Median	13.550	13.600
Std Dev	3.412	3.201
n = 31		

Lab Eliminated: None

2006 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

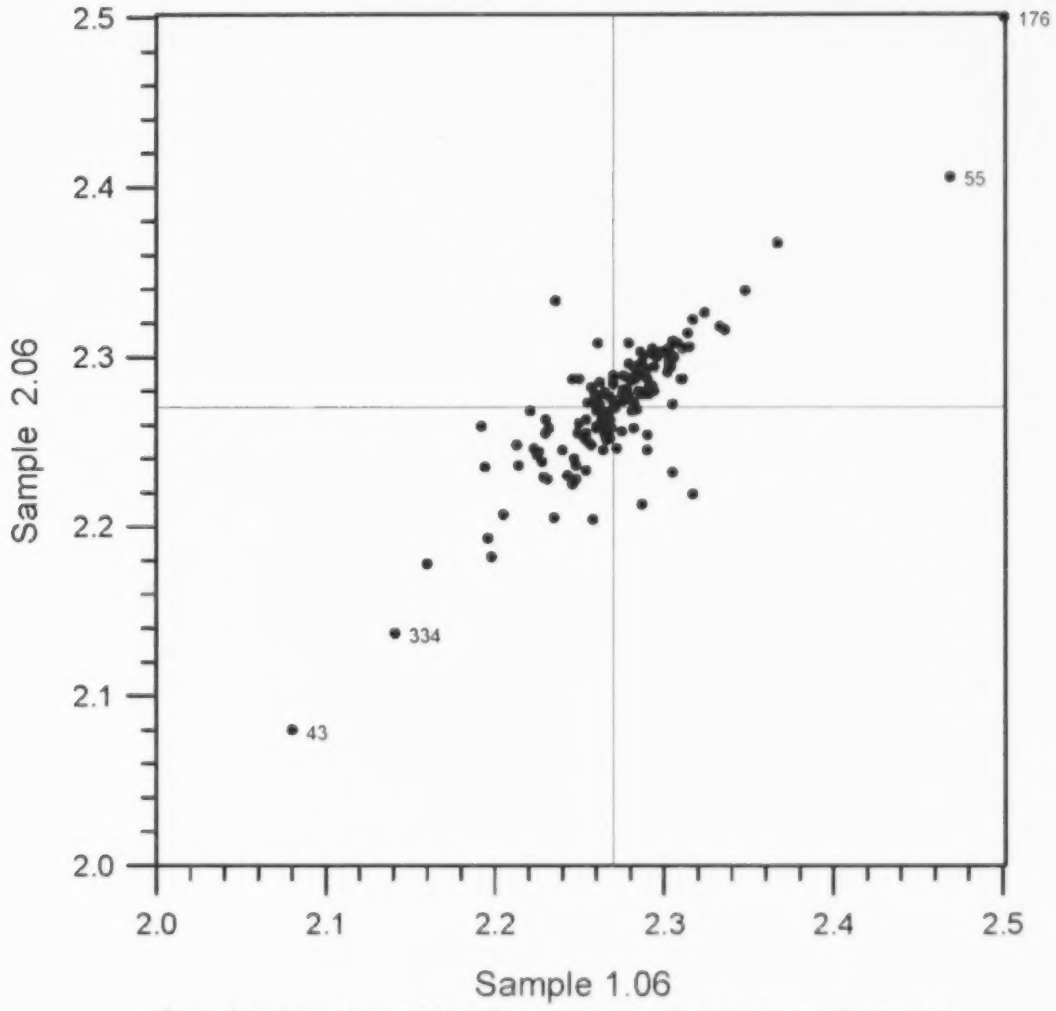


Test 30: Percent Asphalt Coated Particles

	Mat 1	Mat 2
Mean	39.704	39.942
Median	37.400	37.900
Std Dev	4.685	4.708
n = 206		

Lab Eliminated: 4

2006 MTO AGGREGATE AND SOIL
PROFICIENCY SAMPLE TESTING PROGRAM

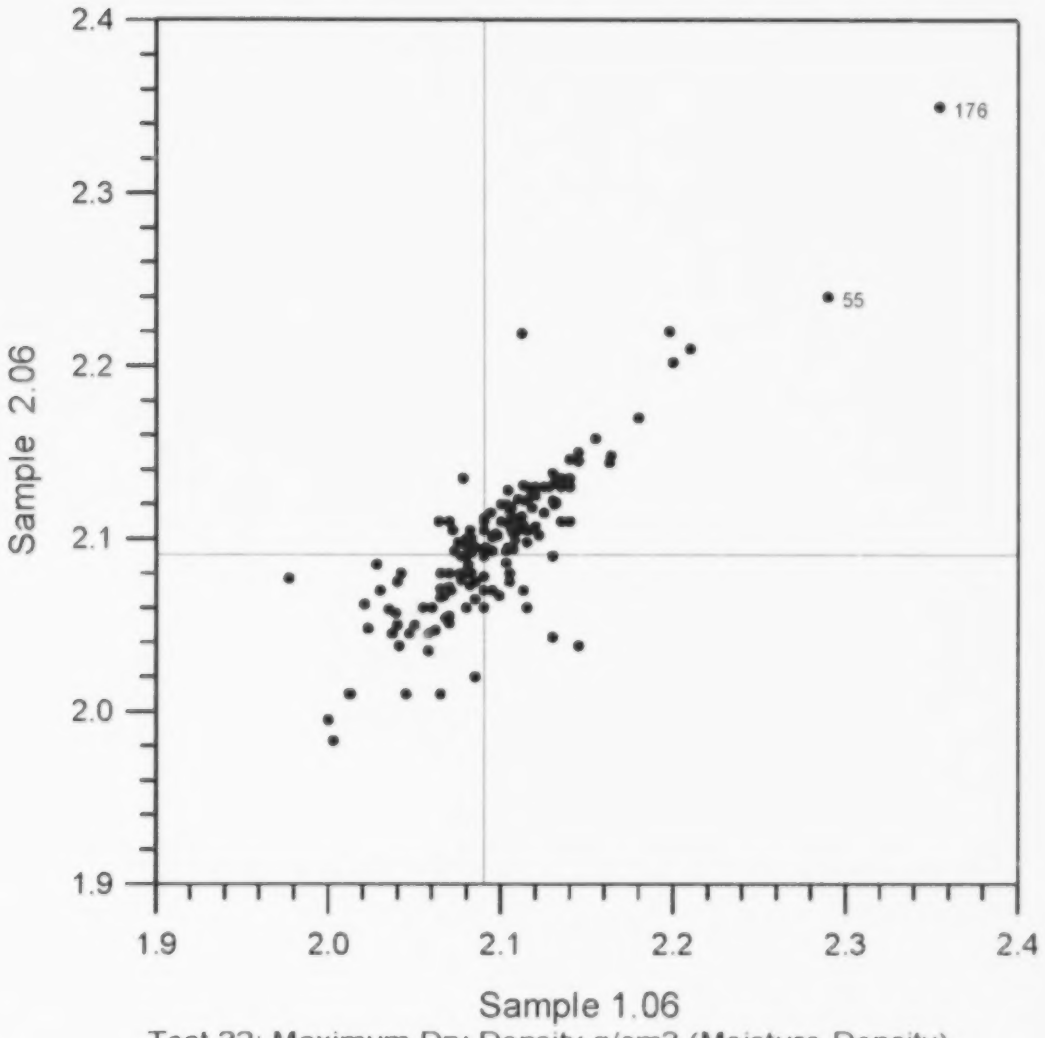


Test 31: Maximum Wet Density g/cm3 (Moisture-Density)

	Mat 1	Mat 2
Mean	2.271	2.272
Median	2.264	2.273
Std Dev	0.031	0.030
n = 147		

Labs Eliminated: 43, 55, 176, 334

2006 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

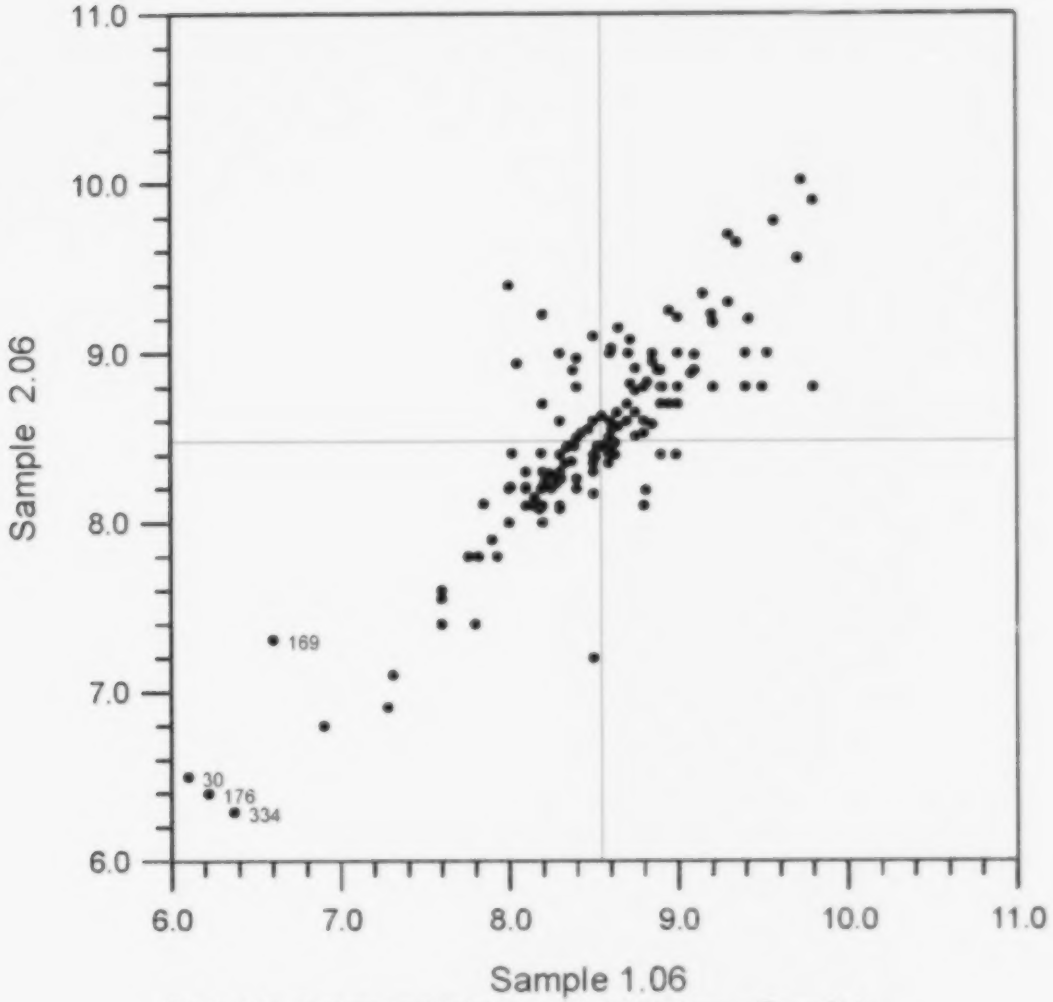


Test 32: Maximum Dry Density g/cm3 (Moisture-Density)

	Mat 1	Mat 2
Mean	2.093	2.095
Median	2.094	2.102
Std Dev	0.038	0.041
n = 149		

Labs Eliminated: 55, 176

2006 MTO AGGREGATE AND SOIL
PROFICIENCY SAMPLE TESTING PROGRAM

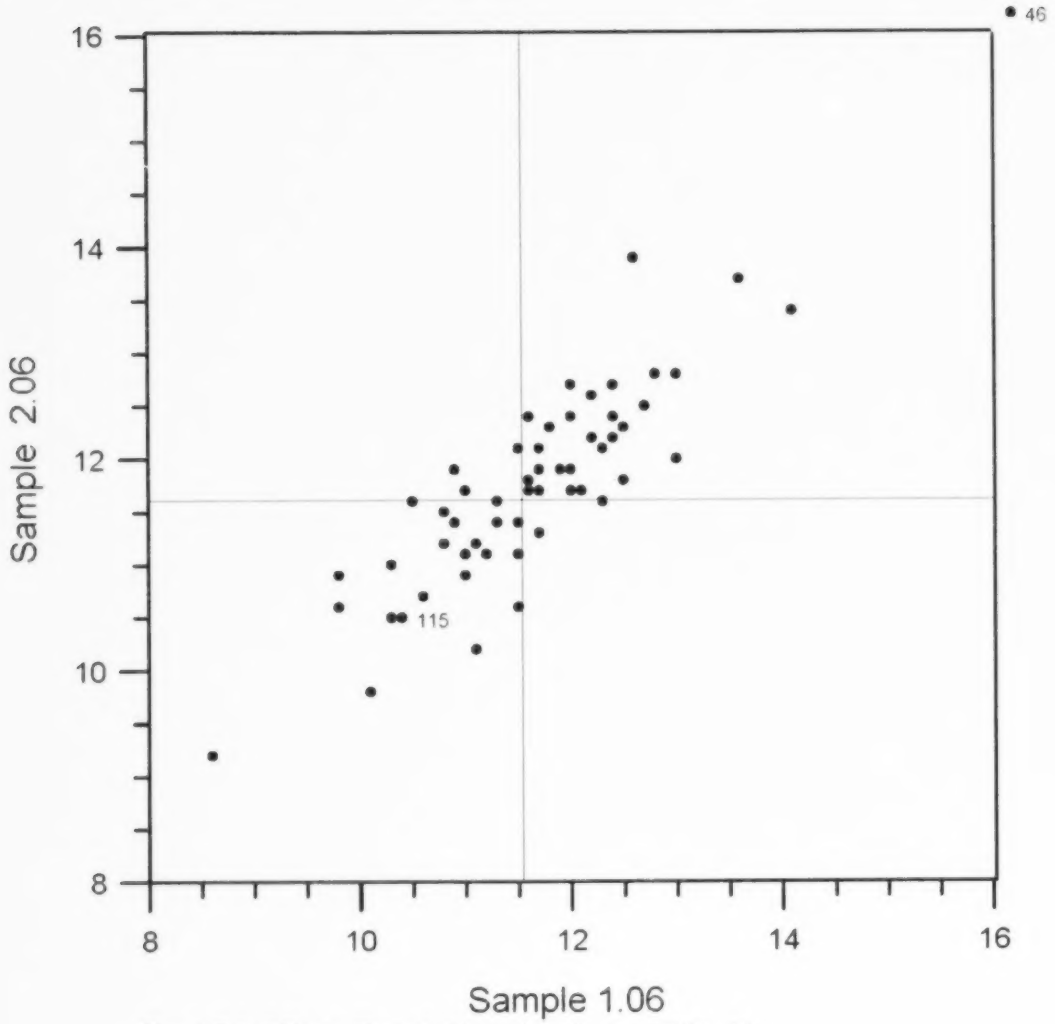


Test 33: Optimum Moisture, % (Moisture - Density)

	Mat 1	Mat 2
Mean	8.550	8.481
Median	8.350	8.410
Std Dev	0.499	0.609
n = 147		

Labs Eliminated: 30, 169, 176, 334

2006 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

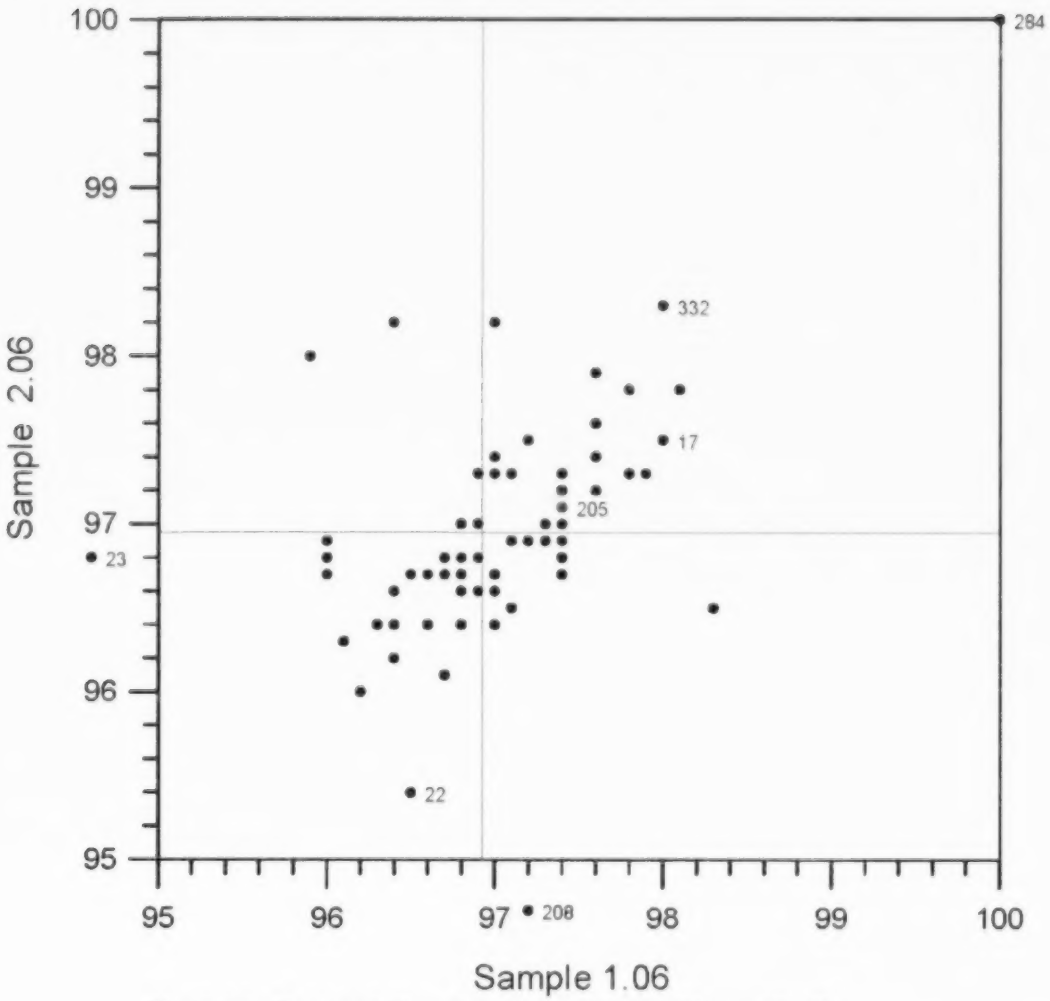


Test 34: Micro-Deval Abrasion Loss (FA), %

	Mat 1	Mat 2
Mean	11.613	11.728
Median	11.350	11.550
Std Dev	0.948	0.846
n = 60		

Lab eliminated: 46, 115

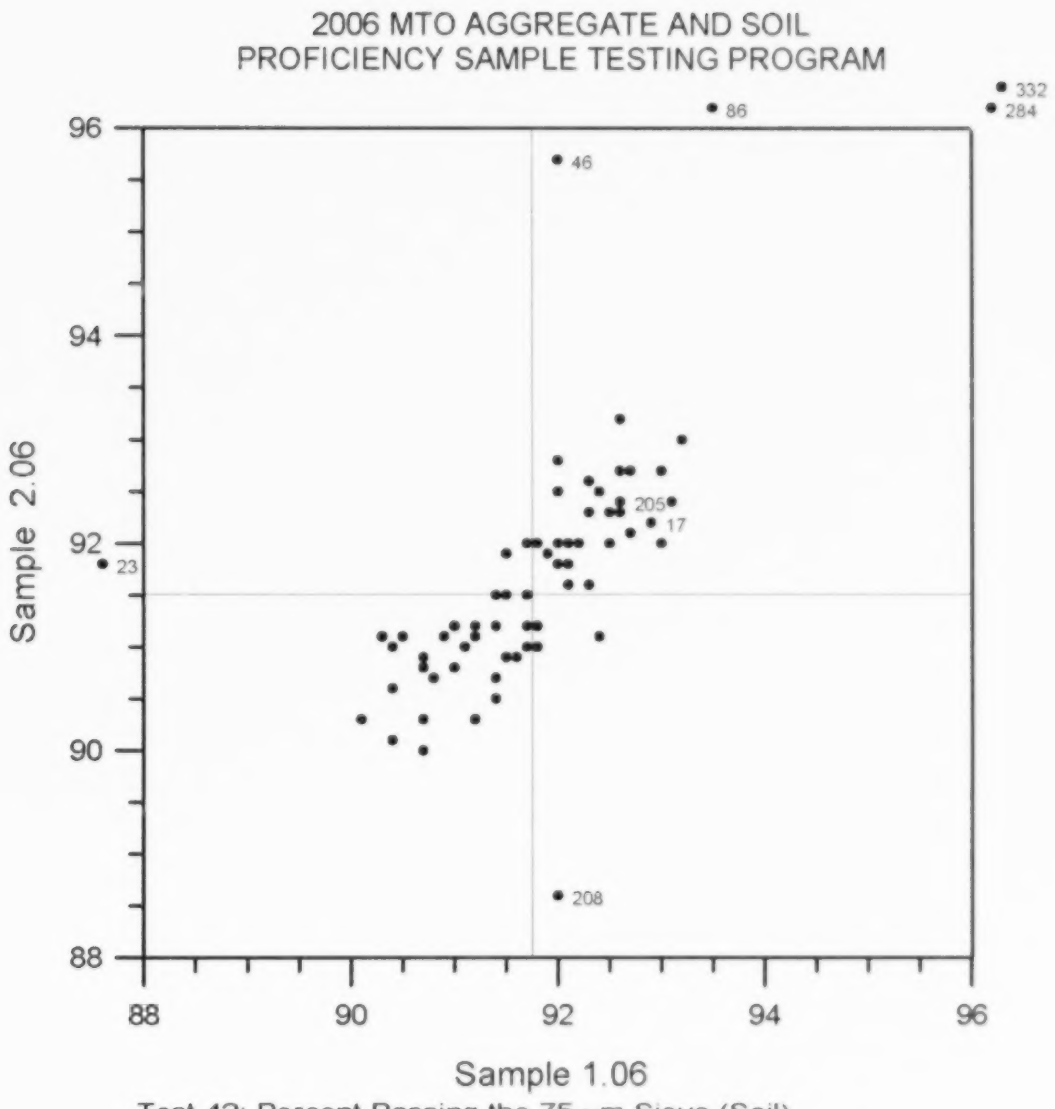
2006 MTO AGGREGATE AND SOIL
PROFICIENCY SAMPLE TESTING PROGRAM



Test 41: Percent Passing the 425 μm Sieve (Soil)

	Mat 1	Mat 2
Mean	96.960	96.945
Median	97.100	97.100
Std Dev	0.562	0.509
n = 61		

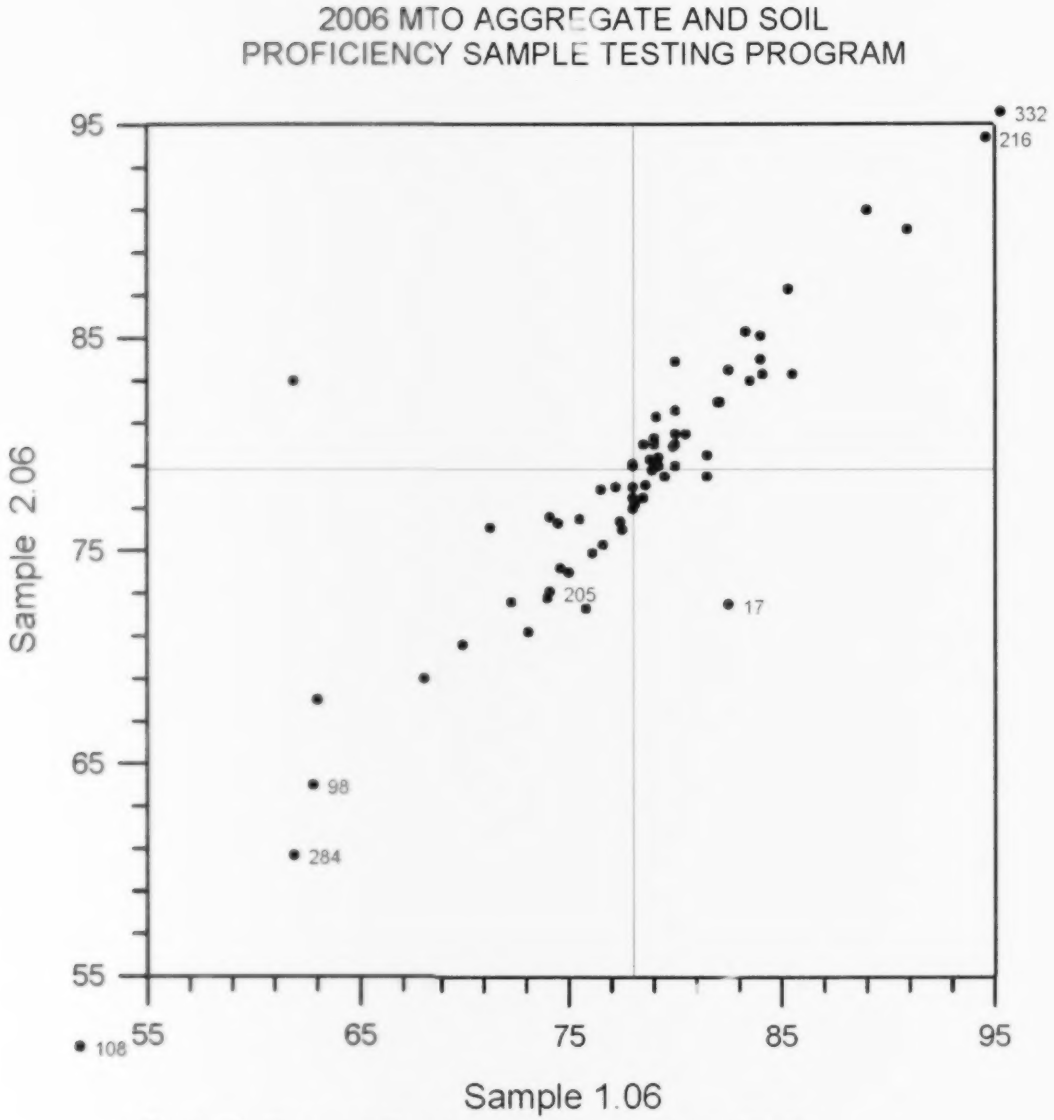
Labs eliminated: 17, 22, 23, 205, 208, 284, 332



Test 42: Percent Passing the 75 μm Sieve (Soil)

	Mat 1	Mat 2
Mean	91.729	91.533
Median	91.650	91.600
Std Dev	0.806	0.784
n = 60		

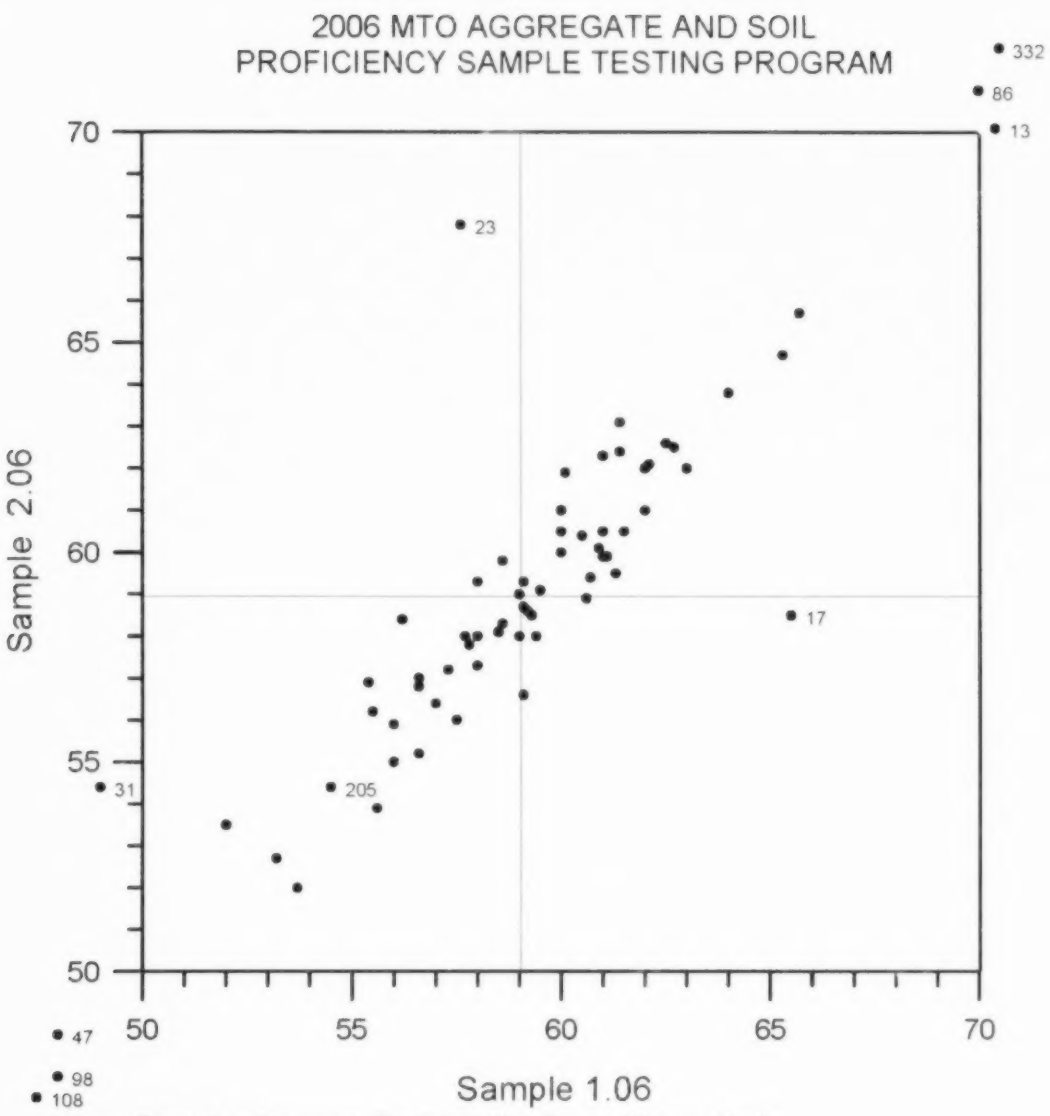
Labs eliminated: 17, 23, 46, 86, 205, 208, 284, 332



Test 43: Percent Passing the 20 μm Sieve (Soil)

	Mat 1	Mat 2
Mean	78.109	78.907
Median	76.400	79.500
Std Dev	6.044	4.521
n = 61		

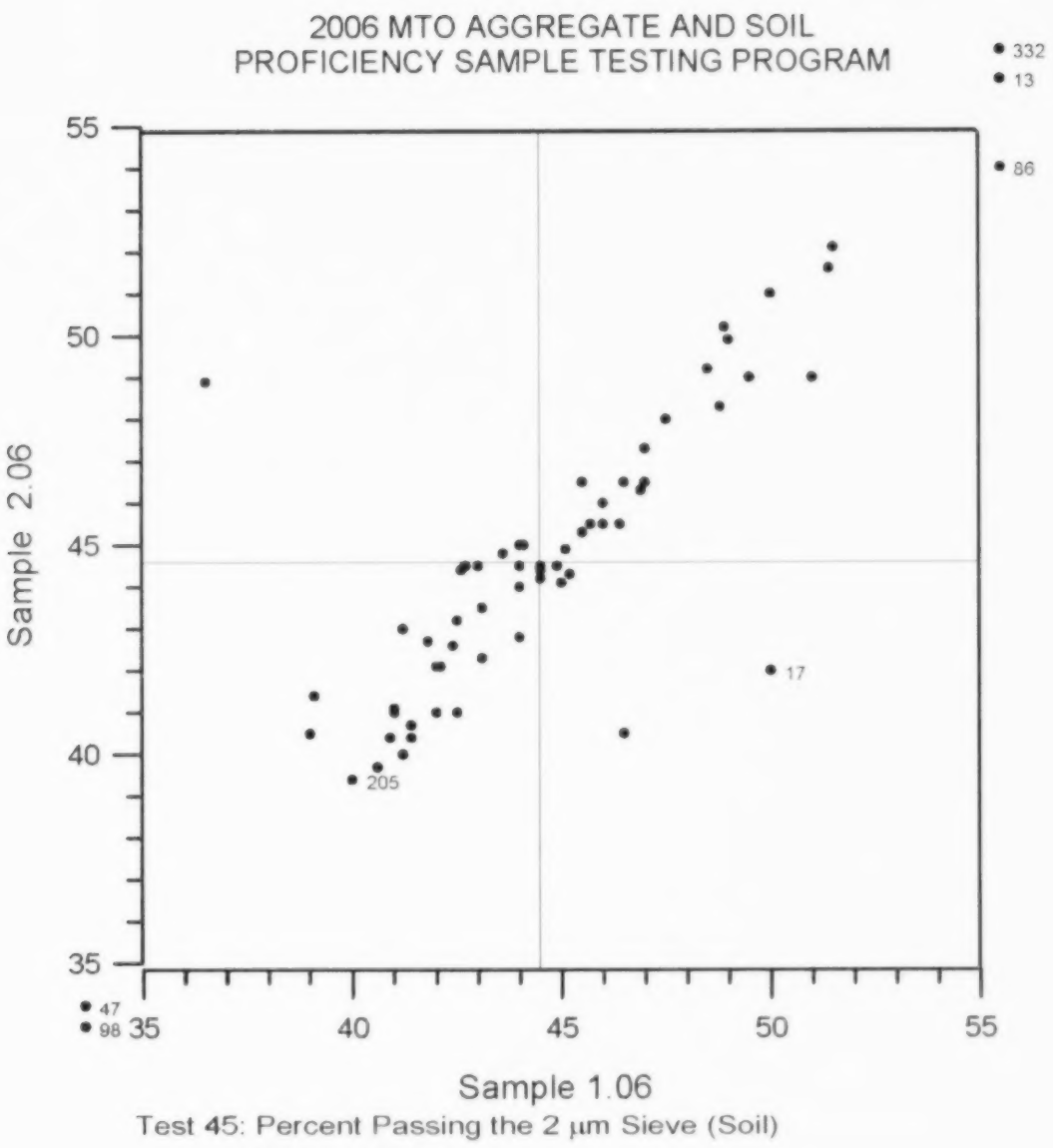
Labs eliminated: 17, 98, 108, 205, 216, 284, 332



Test 44: Percent Passing the 5 µm Sieve (Soil)

	Mat 1	Mat 2
Mean	59.161	58.903
Median	58.850	58.850
Std Dev	2.762	2.876
n = 58		

Labs eliminated: 13, 17, 23, 31, 47, 86, 98, 108, 205, 332

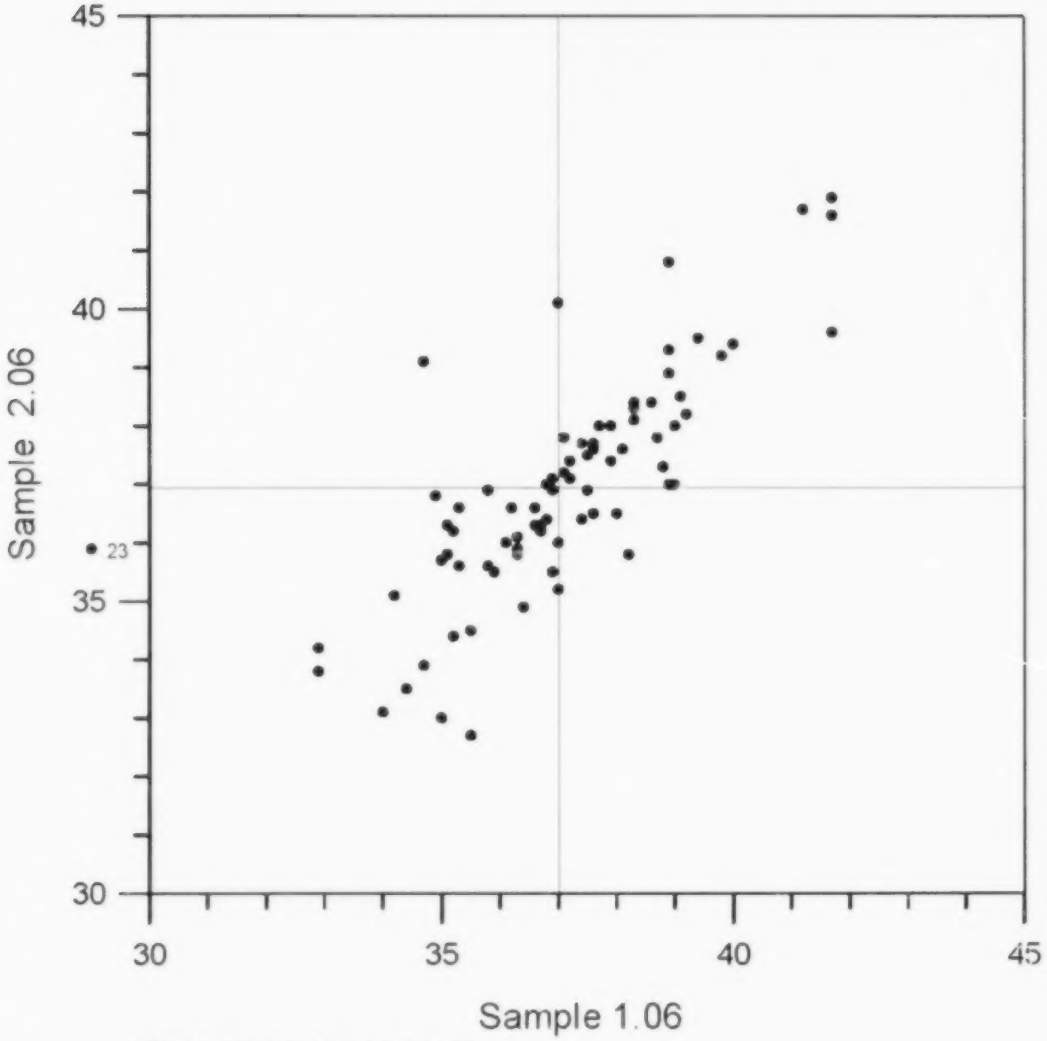


Test 45: Percent Passing the 2 µm Sieve (Soil)

	Mat 1	Mat 2
Mean	44.469	44.643
Median	44.000	45.900
Std Dev	3.143	3.101
n = 61		

LabsEliminated: 13, 17, 47, 86, 98, 205, 332

2006 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

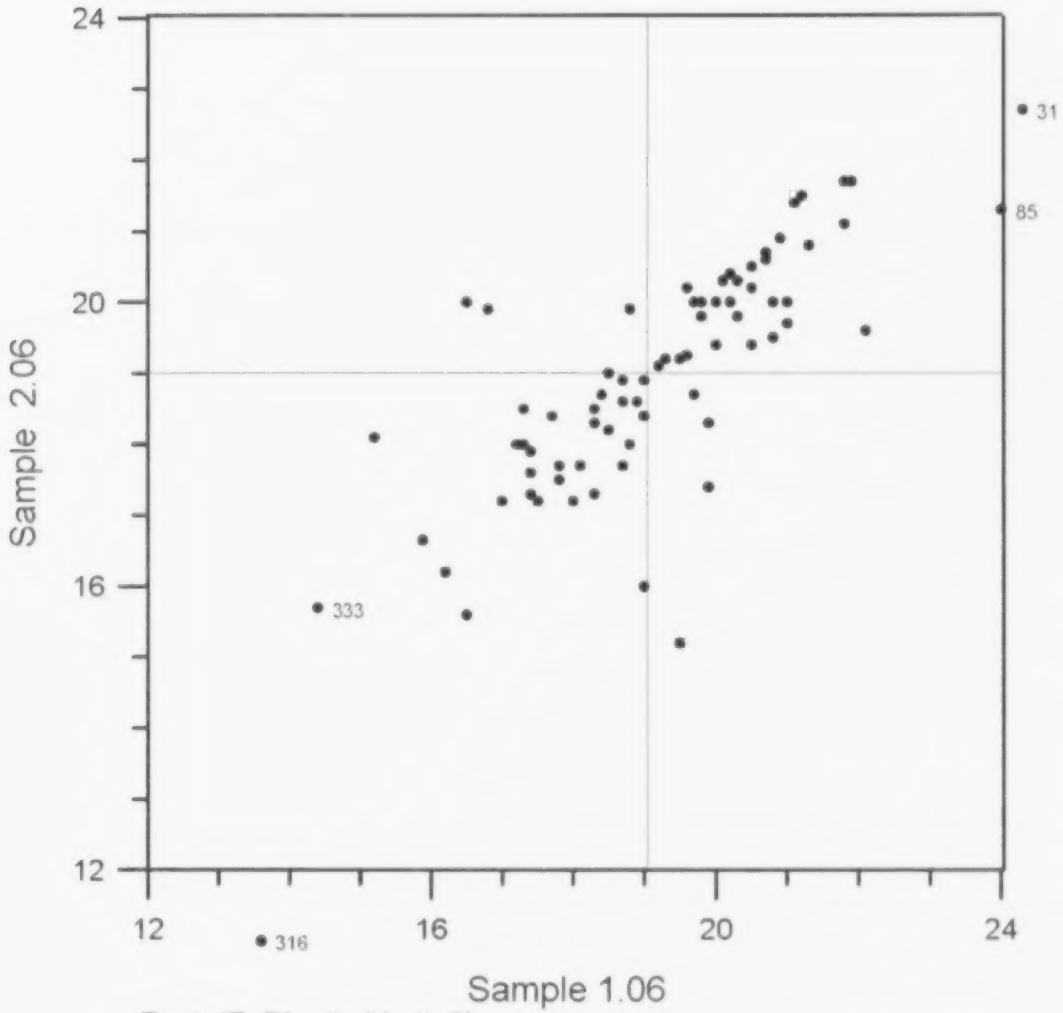


Test 46: Liquid Limit, %

	Mat 1	Mat 2
Mean	37.134	36.937
Median	37.300	37.300
Std Dev	1.887	1.918
n = 77		

Lab eliminated: 23

2006 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

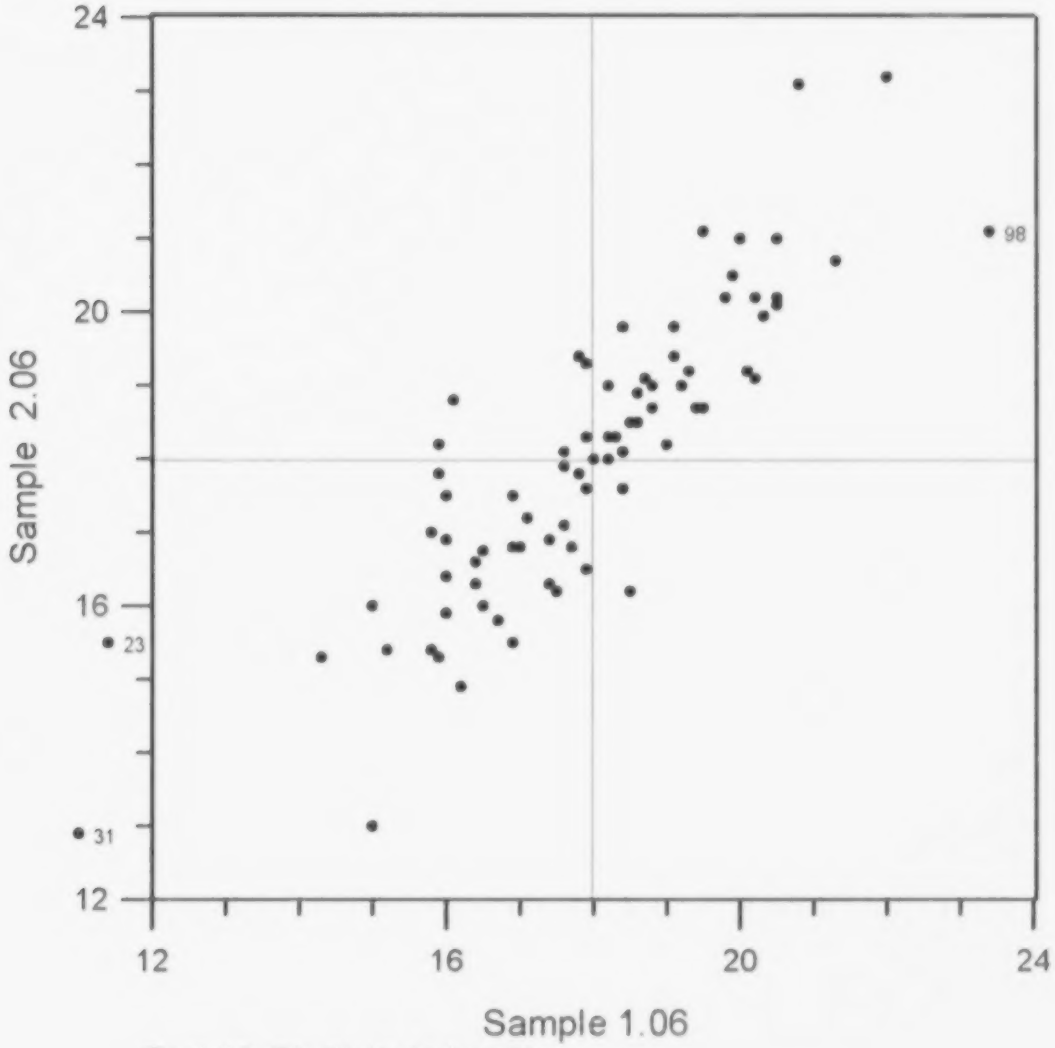


Test 47: Plastic Limit, %

	Mat 1	Mat 2
Mean	19.192	19.048
Median	18.650	18.450
Std Dev	1.569	1.565
n = 74		

Labs eliminated: 31, 85, 316, 333

2006 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

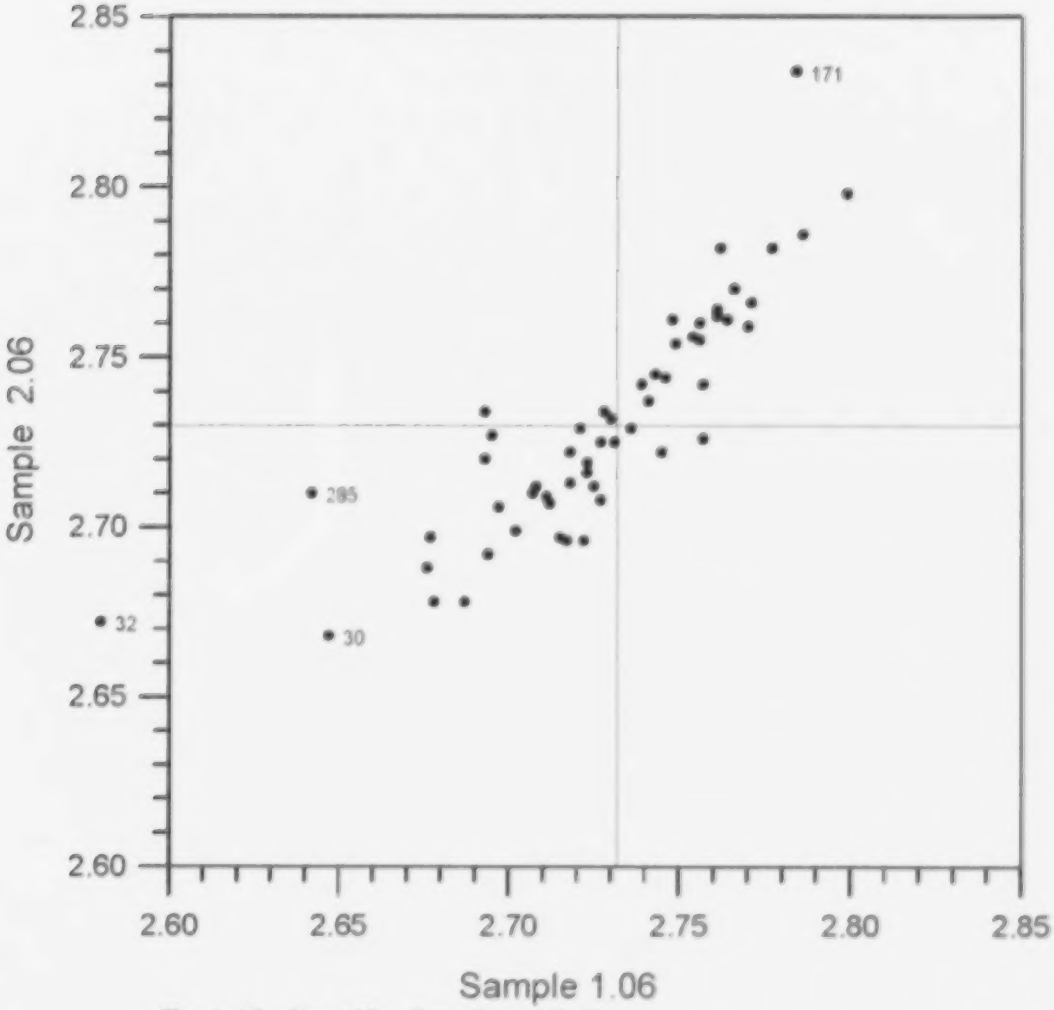


Test 48: Plasticity Index, %

	Mat 1	Mat 2
Mean	17.936	17.982
Median	18.150	18.100
Std Dev	1.676	1.971
n = 75		

Lab eliminated: 23, 31, 98

2006 MTO AGGREGATE AND SOIL PROFICIENCY SAMPLE TESTING PROGRAM

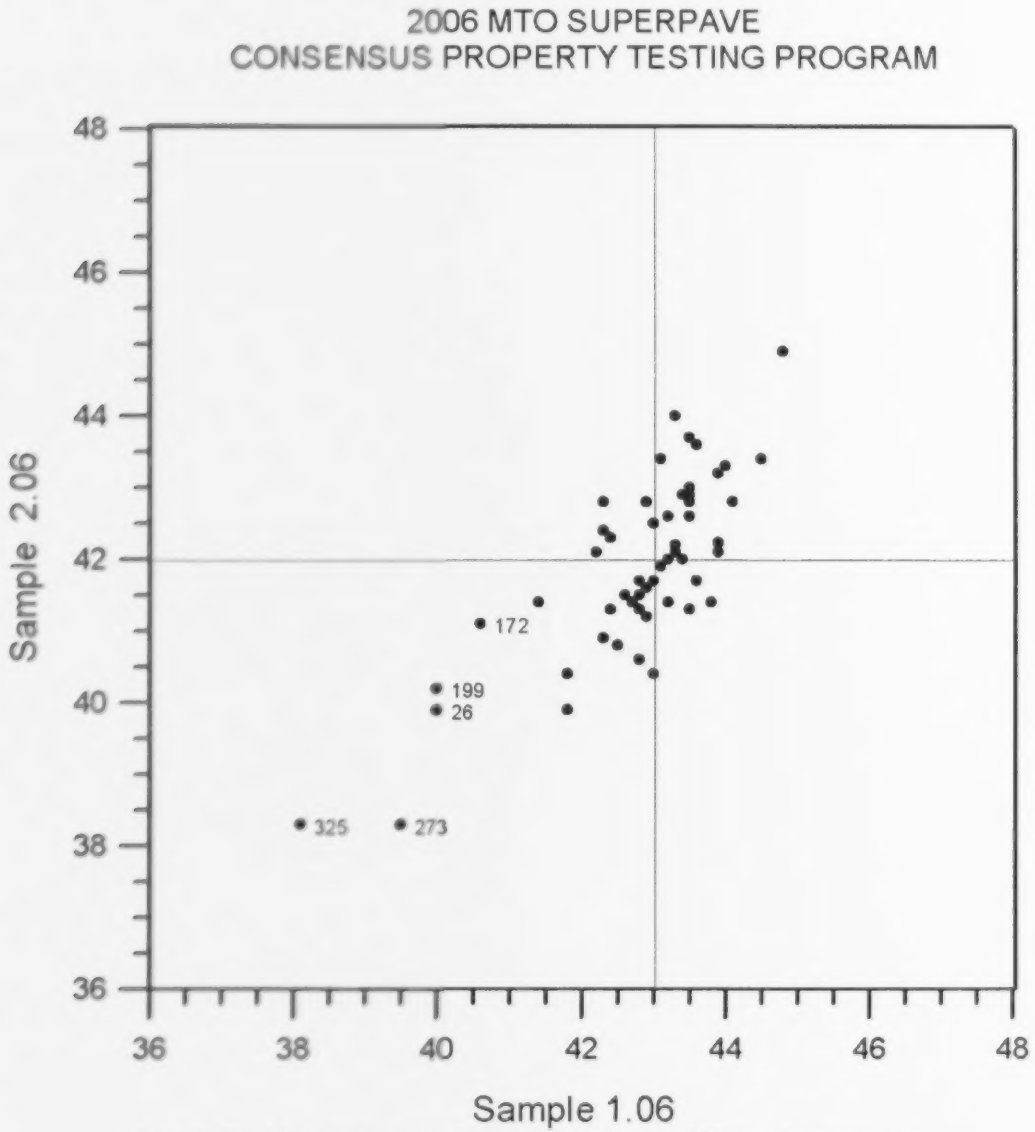


Test 49: Specific Gravity of Soil

	Mat 1	Mat 2
Mean	2.733	2.730
Median	2.738	2.738
Std Dev	0.030	0.031
n = 52		

Labs Eliminated: 30, 32, 171, 285

Appendix D2: Scatter Diagrams

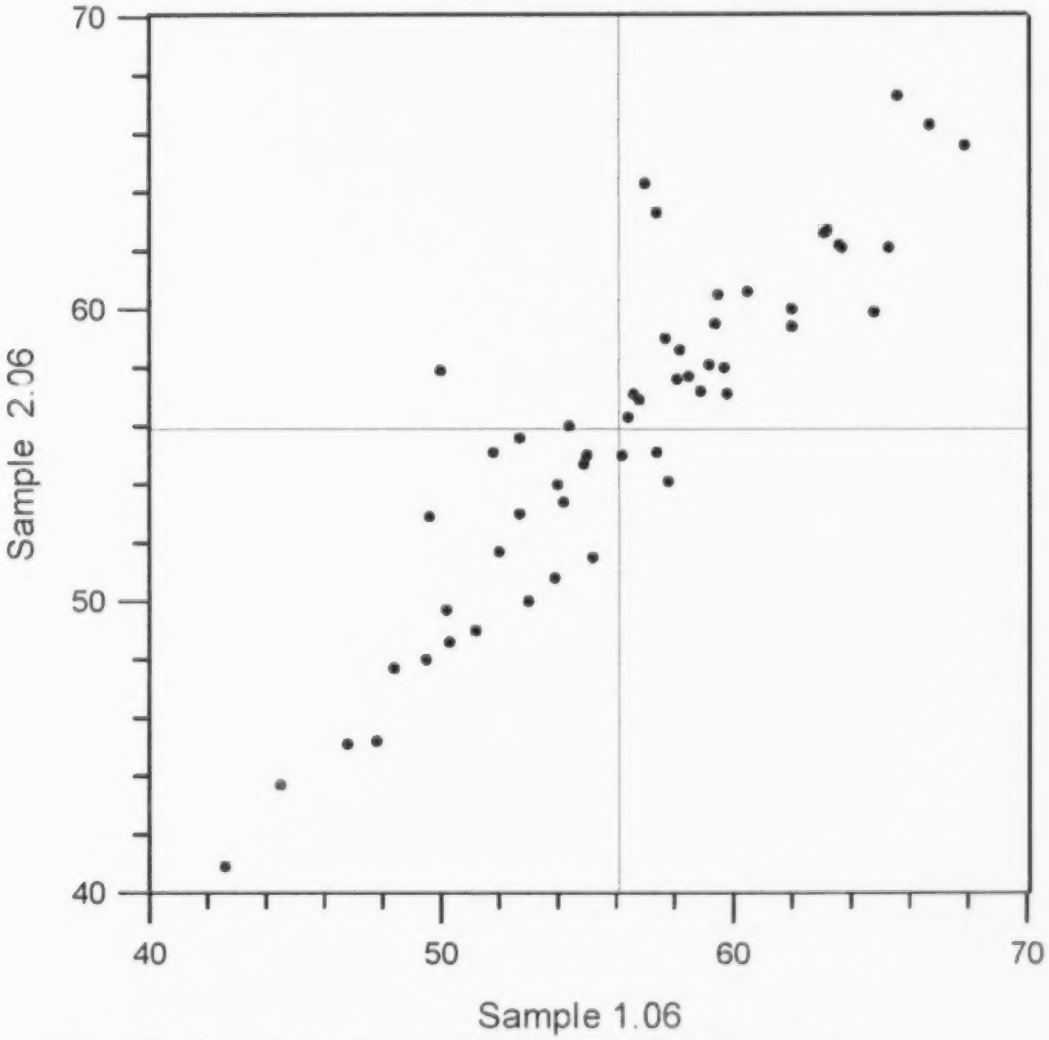


Test 95: Uncompacted Void Content of Fine Aggregate

	Mat 1	Mat 2
Mean	43.132	42.059
Median	43.100	42.400
Std Dev	0.683	1.083
n = 50		

Labs eliminated: 26, 172, 199, 273, 325

2006 MTO SUPERPAVE
CONSENSUS PROPERTY TESTING PROGRAM

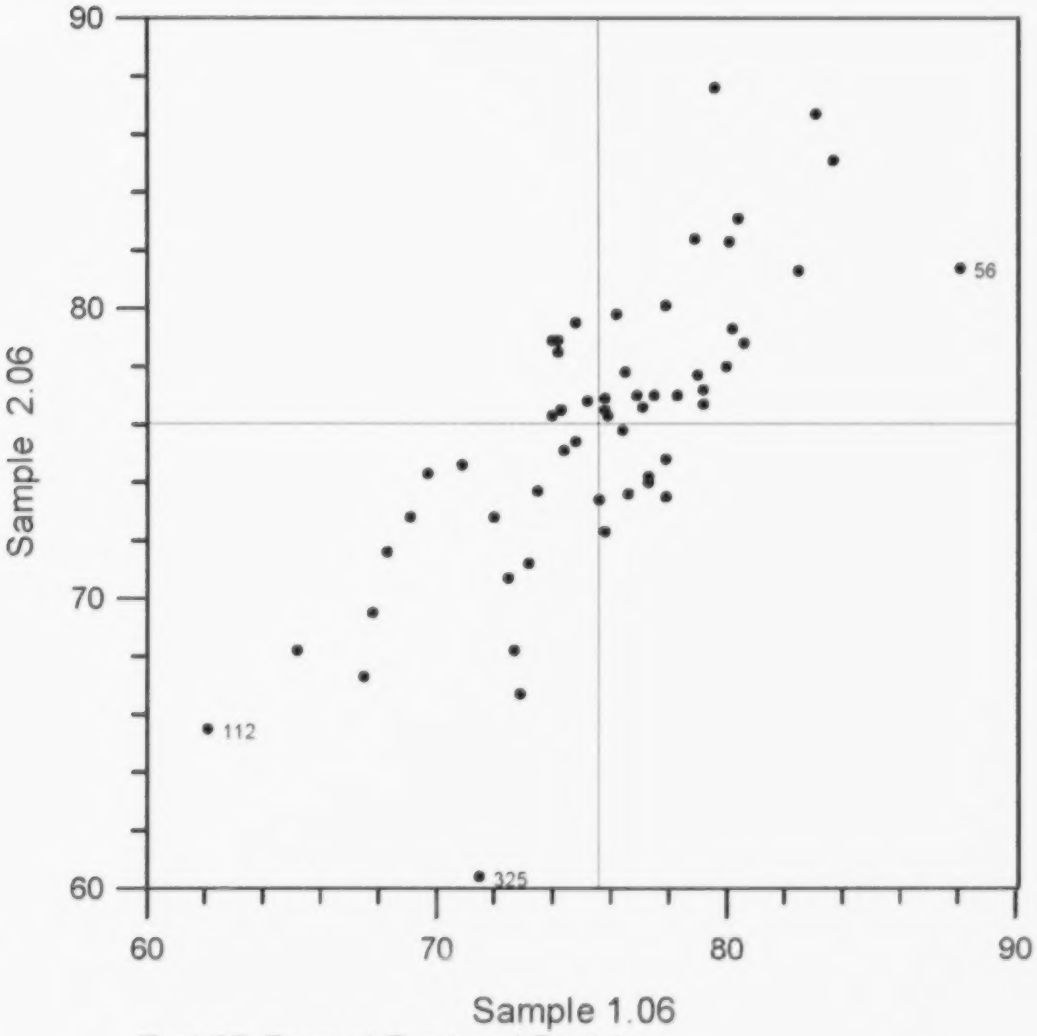


Test 96: Sand Equivalent Value of Fine Aggregate

	Mat 1	Mat 2
Mean	56.372	55.957
Median	55.250	54.100
Std Dev	5.761	5.908
n = 53		

Labs eliminated: None

2006 MTO SUPERPAVE
CONSENSUS PROPERTY TESTING PROGRAM

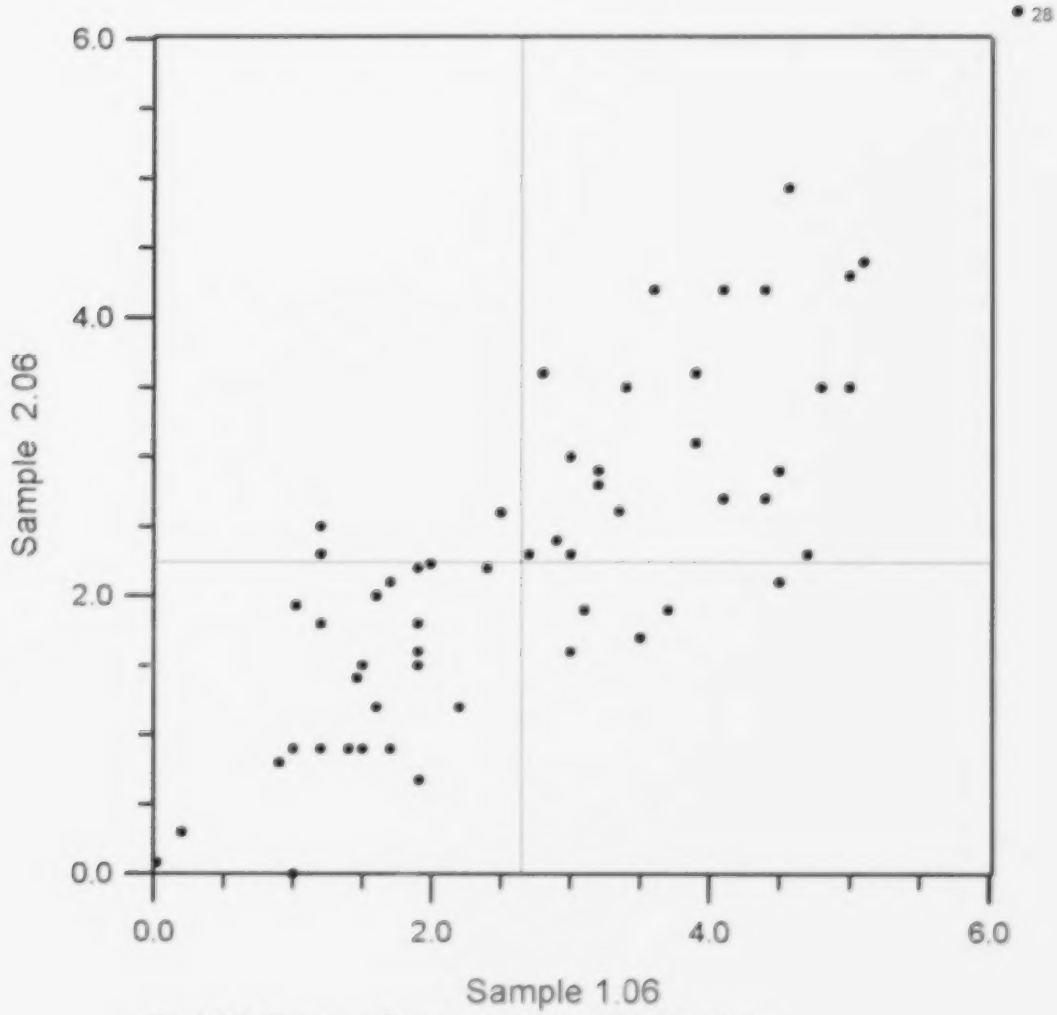


Test 97: Percent Fractured Particles

	Mat 1	Mat 2
Mean	75.667	76.063
Median	74.450	77.150
Std Dev	3.962	4.703
n = 54		

Labs Eliminated: 56, 112, 325

2006 MTO SUPERPAVE
CONSENSUS PROPERTY TESTING PROGRAM



Test 99: Percent Flat and Elongated Particles

	Mat 1	Mat 2
Mean	2.680	2.247
Median	2.560	2.465
Std Dev	1.364	1.157
n = 55		

Lab Eliminated: 28

Appendix E1: Production Laboratory Ratings

Lab No.	LS-601 Wash Pass	LS-602 Gradation	LS-607 % Crushed Particles	LS-621 % Asphalt Coated	LS-608 % Flat & Elongated	Rating
4	4	18.8	0	0	8	**44**
10	9	16.1	10	10		**75**
12	9	29.5	10	9	1	**84**
13	10	22.9	9	10	10	**88**
15	10	25.6	8	9	10	**89**
16	2	28.6	10	7	10	**82**
17	10	21.3	9	8		**80**
18	10	27.5	9	10	10	**95**
19	10	28.6	10	9	10	**97**
20	10	28.4	10	10	10	**98**
22	10	28.6	8	10	10	**95**
23	10	24.5	10	10	10	**92**
25	10	24.0	8	10	10	**89**
26	4	28.6	8	5	10	**79**
28	9	30.0	10	10	10	**99**
29	9	28.1	10	10		**95**
30	5	21.8	10	10	10	**81**
31	9	28.4	10	4	10	**88**
32	10	27.3	0	10	6	**76**
33	10	30.0	10	9	10	**99**
34	10	27.3	0	10	7	**78**
35	10	28.9	10	10	10	**98**
37	9	28.9	10	10	10	**97**
38	10	28.4	5	9	9	**88**
39	10	28.6	10	10	10	**98**
43	8	27.0	0	10	10	**79**
44	9	29.5	6	10		**91**
45	10	29.5	10	9	10	**98**
46	10	27.5	10	10	10	**96**
47	8	28.9	10	10	10	**96**
54	10	27.5	10	9	10	**95**
55	8	20.2	10	10	4	**75**
56	10	29.2	9	10	10	**97**
58	8	25.4	10	10	5	**83**
59	10	25.1	10	10	10	**93**
61	9	19.4	10	9	10	**82**
64	10	24.5	9	10	9	**89**
68	10	29.5	10	10	10	**99**
69	10	29.7	8	9	10	**95**

Lab No.	LS-601 Wash Pass	LS-602 Gradation	LS-607 % Crushed Particles	LS-621 % Asphalt Coated	LS-608 % Flat & Elongated	Rating
71	8	25.4	10	10	8	**88**
72	10	28.1	9	9		**93**
73	10	27.5	9	6	9	**88**
79	10	29.2	10	10	10	**99**
80	10	27.8	8	10	10	**94**
81	10	29.7	10	4	0	**77**
83	10	26.5	0	10	10	**81**
85	10	19.6	10	9	9	**82**
86	10	27.3	10	10	10	**96**
90	9	27.5	8	10	10	**92**
98	3	27.3	10	5	10	**79**
100	10	29.5	10	10	10	**99**
101	10	29.7	9	10	10	**98**
102	10	27.3	10	10	10	**96**
103	10	21.8	4	10	8	**77**
104	9	25.9	8	10	9	**88**
105	10	29.2	10	9		**97**
107	6	27.5	8	9	10	**86**
108	10	29.5	9	7	10	**94**
110	10	28.4	9	10	10	**96**
112	10	28.6	9	10	10	**97**
113	10	28.1	10	9	10	**96**
115	10	25.1	10	5	4	**77**
116	10	29.7	9	10	10	**98**
117	9	28.6	9	10	10	**95**
120	9	26.5	9	10	10	**92**
123	10	29.2	10	10	10	**99**
124	10	24.8	10	9	10	**91**
126	7	20.7	7	5		**66**
127	10	27.3	10	8		**92**
128	10	27.5	10	10		**96**
129	10	28.4	10	10	10	**98**
134	10	23.5	10	10	10	**91**
136	9	26.5	9	10	10	**92**
137	10	27.0	9	10	10	**94**
138	8	28.1	10	10	10	**94**
139	10	23.2	4	1		**64**
141	10	30.0	10	9	6	**93**
144	10	28.9	10	6	10	**93**
146	10	28.6	10	10		**98**
147	10	22.9	10	3		**77**
153	1	28.6	10	10	10	**85**
157	6	25.9	8	10	4	**77**

Lab No.	LS-601 Wash Pass	LS-602 Gradation	LS-607 % Crushed Particles	LS-621 % Asphalt Coated	LS-608 % Flat & Elongated	Rating
158	10	28.9	10	8	2	**84**
161	10	28.1	10	5	10	**90**
163	10	29.7	10	10		**100**
164	9	28.6	9	10	10	**95**
167	0	25.4	10	10	10	**79**
169	5	21.5	9	4	9	**69**
171	0	30.0	10	10	10	**86**
172	10	25.4	7	8	10	**86**
175	10	30.0	10	10	10	**100**
176	5	24.3	10	6		**75**
177	10	29.2	10	10	10	**99**
178	10	29.2	0	10	10	**85**
179	10	25.6	0	10	10	**79**
180	9	28.9	0	10	9	**81**
181	7	27.8	10	6		**85**
182	9	30.0	9	9	10	**96**
184	10	28.6	10	7	9	**92**
187	10	28.9	10	10	0	**84**
188	10	28.4	10	10	10	**98**
189	7	28.4	10	9	10	**92**
191	9	29.7	7	10	8	**91**
193	10	29.2	10	10	10	**99**
194	0	28.6	10	10	10	**84**
198	0	25.4	3	10	5	**62**
199	10	27.8	10	10	10	**97**
200	6	30.0	10	9	0	**79**
201	10	28.6	10	7		**93**
202	10	27.5	10	7		**91**
204	9	25.9	10	10	10	**93**
205	9	30.0	9	10	8	**94**
208	10	28.9	10	9	3	**87**
210	2	27.5	10	10		**83**
212	10	22.9	10	9	7	**84**
214	10	27.3	10	10	8	**93**
215	0	28.4	8	8	8	**75**
216	10	28.9	9	9	10	**96**
217	10	22.6	10	9		**86**
218	9	29.5	10	10	10	**98**
219	10	19.6	8	10	10	**82**
221	10	18.3	10	10	10	**83**
223	10	13.4	10	9		**71**
224	10	24.5	8	10	10	**89**
228	10	28.1	10	10	10	**97**

Lab No.	LS-601 Wash Pass	LS-602 Gradation	LS-607 % Crushed Particles	LS-621 % Asphalt Coated	LS-608 % Flat & Elongated	Rating
232	10	21.0	10	9	6	**80**
234	10	29.2	7	10	10	**95**
235	9	25.1	10	10	3	**82**
236	10	29.2	10	10	9	**97**
242	10	25.6	10	9	9	**91**
245	10	28.6	7	10	10	**94**
246	10	29.5	10	10	10	**99**
247	8	29.2	8	9	9	**90**
248	10	25.1	9	10	10	**92**
249	8	22.9	10	10	10	**87**
250	9	27.3	10	10		**94**
251	10	25.6	10	10		**93**
252	2	12.8	10	7		**53**
253	10	22.4	10	10	8	**86**
254	10	28.9	10	10	10	**98**
255	10	29.2	10	10	9	**97**
256	10	29.2	10	9	10	**97**
257	8	29.5	10	7		**91**
258	9	23.7	10	10	10	**90**
259	7	28.1	10	7	10	**89**
260	9	30.0	10	10	10	**99**
262	5	27.3	9	6	3	**72**
263	10	23.5	10	10	10	**91**
264	10	16.1	10	10	10	**80**
269	10	30.0	0	10	10	**86**
271	10	26.2	9	10	10	**93**
272	10	29.5	4	10	10	**91**
273	10	22.4	10	10	5	**82**
274	4	28.4	10	10	10	**89**
275	8	29.2	10	10	10	**96**
276	10	29.5	10	10	10	**99**
277	8	27.8	8	8	10	**88**
278	10	28.1	6	10	10	**92**
279	10	30.0	10	8	8	**94**
280	8	27.0	9	5	9	**83**
284	8	26.2	6	5	0	**65**
285	10	28.6	9	10	10	**97**
287	8	27.8	10	9		**91**
288	10	28.6	5	10	10	**91**
290	10	27.0	10	8	10	**93**
291	10	26.5	9	10	1	**81**
292	4	13.6	10	10		**63**
293	10	28.4	10	7		**92**

Lab No.	LS-601 Wash Pass	LS-602 Gradation	LS-607 % Crushed Particles	LS-621 % Asphalt Coated	LS-608 % Flat & Elongated	Rating
294	10	29.2	9	10	10	**97**
295	9	27.8	10	9	10	**94**
297	10	18.8	10	10	7	**80**
299	10	29.5	7	10	9	**94**
300	10	29.5	10	10	10	**99**
301	10	27.3	9	10	10	**95**
302	10	27.8	10	2	10	**85**
303	10	28.6	5	10	1	**78**
304	10	26.2	10	10		**94**
305	10	29.2	6	10		**92**
308	10	30.0	8	9		**95**
309	10	26.5	10	10	10	**95**
311	10	28.6	10	10		**98**
313	10	25.6	10	6		**86**
314	8	24.8	3	9		**75**
315	5	30.0	10	9	9	**90**
316	9	28.1	10	10	10	**96**
317	10	28.9	7	10	10	**94**
318	6	25.4	9	10	10	**86**
320	1	28.9	9	10		**82**
321	10	27.3	8	10	10	**93**
322	7	30.0	8	10		**92**
323	7	22.4	9	10	10	**83**
324	8	29.2	6	9	6	**83**
325	10	29.7	6	10	10	**94**
326	10	27.0	6	6	8	**81**
327	10	30.0	0	10	7	**81**
328	10	30.0	7	10	10	**96**
329	8	28.4	7	2	10	**79**
330	10	28.9	4	10	8	**87**
331	10	22.6	10	8		**84**
332	10	26.2	7	9	0	**75**
333	10	25.6	8	7		**84**
334	10	25.6	8	10		**89**
336	10	28.9	10	10	10	**98**
337	10	22.4	10	7		**82**
338	10	24.5	9	9	10	**89**
339	10	30.0	0	10	10	**86**
340	9	30.0	9	10	10	**97**

Appendix E2: Full Service Ag

FULL SERVICE AGGREGAT

Lab No.	LS-601 Wash Pass	LS-602 Gradation	LS-603 LAA	LS-604 BRD/ABS (CA)	LS-606 $MgSO_4$ (CA)	LS-607 % Crush	LS-621 % Asphalt	% El
13	10	22.9		9.5	7	9	10	
15	10	25.6		9.5	10	8	9	
18	10	27.5		9.5	10	9	10	
19	10	28.6		8		10	9	
22	10	28.6		9		8	10	
23	10	24.5		9.5	9	10	10	
28	9	30.0		8.5		10	10	
31	9	28.4	7	8	5	10	4	
35	10	28.9	8	10	9	10	10	
37	9	28.9	10	10	10	10	10	
38	10	28.4	8	9	7	5	9	
46	10	27.5		10	10	10	10	
47	8	28.9	10	6.5	10	10	10	
56	10	29.2	10	9	10	9	10	
59	10	25.1		10	10	10	10	
61	9	19.4		7.5	9	10	9	
79	10	29.2		10		10	10	
80	10	27.8	10	6.5	8	8	10	
83	10	26.5		5.5	9	0	10	
86	10	27.3		6.5		10	10	
98	3	27.3		3	0	10	5	
100	10	29.5		9	10	10	10	
101	10	29.7	8	9	10	9	10	
107	6	27.5		8.5	10	8	9	
108	10	29.5		7	4	9	7	

gregate Laboratory Ratings

LABORATORY RATINGS 2006

-608 Flat & gated	LS-618 MDA (CA)	LS-614 F/T	LS-605 BRD/ABS (FA)	LS-606 $MgSO_4$ (FA)	LS-623 One Point Proctor	LS-619 MDA (FA)	Rating
10	9	9	9	10	9.7	10	**90**
10	10	9	10	10	10.0	10	**94**
10	10	8	9.5	10	8.3	4	**91**
10	10	10	10		6.7	10	**94**
10	10	8	9		10.0	10	**94**
10	8	5	4	9	9.7	10	**86**
10	10	8	10		8.7	10	**96**
10	0	10	10	8	10.0	5	**78**
10	10	10	10	3	10.0	10	**93**
10	8	10	10	10	10.0	10	**97**
9	9	10	10	10	10.0	10	**90**
10	4	2	9		2.7	0	**75**
10	10	10	10	10	10.0	10	**96**
10	10	10	10	10	10.0	10	**98**
10	10	9	9.5	10	10.0	10	**96**
10	8	10	10		10.0	8	**86**
10	10	10	10		10.0	9	**99**
10	9	10	9	10	9.7	10	**92**
10	10	10	9.5		6.0	10	**83**
10	10	10	9.5		9.7	9	**94**
10	7	10	4.5	7	8.3	9	**69**
10	10	10	10			10	**99**
10	10	10	10	10	10.0	10	**97**
10	9	7	10	10		8	**88**
10	4		10	10	8.3	5	**81**

Testing Program for 2006; MERO-025

Lab No.	LS-601 Wash Pass	LS-602 Gradation	LS-603 LAA	LS-604 BRD/ABS (CA)	LS-606 $MgSO_4$ (CA)	LS-607 % Crush	LS-621 % Asphalt	% El
110	10	28.4		9.5	8	9	10	
112	10	28.6		9.5	10	9	10	
123	10	29.2		9	10	10	10	
124	10	24.8		10		10	9	
157	6	25.9		8	10	8	10	
164	9	28.6		10	10	9	10	
172	10	25.4		7.5	10	7	8	
177	10	29.2		9.5		10	10	
188	10	28.4	10	10	10	10	10	
199	10	27.8		10		10	10	
205	9	30.0		9.5		9	10	
216	10	28.9		9.5	9	9	9	
245	10	28.6		10		7	10	
260	9	30.0		6.5	9	10	10	
263	10	23.5		8.5	10	10	10	
285	10	28.6		7.5	10	9	10	
295	9	27.8		2.5	10	10	9	
301	10	27.3		10	8	9	10	
316	9	28.1		9	9	10	10	
325	10	29.7		10		6	10	

S-608 Flat & rigated	LS-618 MDA (CA)	LS-614 F/T	LS-605 BRD/ABS (FA)	LS-606 $MgSO_4$ (FA)	LS-623 One Point Proctor	LS-619 MDA (FA)	Rating
10	10	9	10		9.3	10	95
10	6	10	10	9	9.7	10	95
10	9	9	10	8	10.0	8	95
10	9	10	10		10.0	10	94
4	10	9	9	10		10	86
10	8	10	7.5	9		10	94
10	10	7	8.5	10	10.0	1	83
10	9	9	10		9.7	10	97
10	10	10	9	8	10.0	10	97
10	9	10	8.5		10.0	10	96
8	9	10	9		10.0	10	95
10	9	7	10	10	10.0	10	94
10	10	8	10		10.0	8	94
10	8	8	7	8	8.0	9	88
10	10	6	9	10	10.0	8	90
10	10	2	8		9.7	10	89
10	10	10	10	8	10.0	10	91
10	10	7	10	10	10.0	10	94
10	9	9	5	10	10.0	10	92
10	8	10	8.5		10.0	10	94

Appendix E3: Soil Laboratory Ratings

Lab No.	LS-702 Hydrometer Analysis	LS-703 & 4 Atterberg Limits	LS-705 Specific Gravity	Rating
12	10.0	10.0	10	100
15	9.8	8.0	9	89
18	8.8	9.0	10	93
19	8.8	9.3	10	94
20	7.4	9.0	10	88
22	7.4	10.0	10	91
23	5.2	5.7	10	70
28	9.8	9.3	9	94
29	9.8	10.0	9	96
30	8.0	9.7	0	59
31	7.0	4.3	9	68
32	9.6	10.0	2	72
34	9.8	9.3	10	97
35	8.8	9.3	10	94
37	9.0	8.7	10	92
38	10.0	9.3	7	88
44	9.8	9.7	10	98
46	8.8	9.3	10	94
47	5.0	9.7	8	76
54	9.2	9.3	9	92
56	8.4	9.7	7	84
58	8.8	9.7	10	95
59	9.6	7.3	10	90
64	8.2	6.7	8	76
68	10.0	9.7	10	99
69	9.2	10.0	6	84
71	9.4	10.0	8	91
72	9.4	10.0	10	98
79	9.8	10.0	9	96
80	10.0	9.7	10	99
83	9.8	10.0	10	99
86	2.2	9.7	6	60
94	9.6	10.0	9	95
98	4.0	6.3	8	61
101	7.6	10.0	6	79
102	9.2	9.7	10	96
108	5.0	7.3	9	71
112	9.4	10.0	10	98

Lab No.	LS-702 Hydrometer Analysis	LS-703 & 4 Atterberg Limits	LS-705 Specific Gravity	Rating
120	9.8	10.0	10	99
123	9.2	7.3	10	88
138	9.4	10.0	10	98
146	8.4	9.0	9	88
171	9.6	7.3	3	66
172	9.8	8.7	9	92
188	8.8	9.3	10	94
208	5.8	9.7	8	78
210	9.6	7.3	10	90
216	7.4	10.0	10	91
253	8.2	7.7	4	66
260	10.0	6.3	8	81
284	2.8	9.3	7	64
285	9.8	8.7	5	78
300	6.2	6.3	10	75
301	9.2	9.3	9	92

Appendix E4: Superpave Laboratory Ratings

Laboratory No.	C 1252/T304 Uncompacted Void Content	D 2419/T176 Sand Equivalent	ASTM D 5821 % Fractured Particles	ASTM D 4719 % Flat & Elongated	Rating
13	9	9	10	10	95
15	8	8	5	9	75
18	10	10	8	10	95
19	9	6	8	10	83
22	8	8	10	10	90
26	3	9	7	9	70
28	10	10	10	0	75
31	9	10	10	10	98
33	6	10	10	10	90
35	10	10	10	10	100
37	10	10	9	10	98
39	9	10	9	10	95
43	9	4	5	6	60
47	10	10	9	7	90
56	8	10	4	10	80
58	10	9	8	10	93
59	10	7	10	10	93
61	10	10	10	7	93
69	6	6	10	7	73
71	8	10	10	6	85
79	10	10	9	10	98
80	3	10	10	9	80
83	10	10	4	9	83
86	10	9	10	8	93
100	10	10	8	9	93
112	10	10	2	10	80
120	10	10	10	8	95
123	10	8	10	6	85
124	10	10	10	10	100
157	8	9	10	8	88
172	5	10	8	10	83
182	9	10	10	10	98
188	10	10	10	7	93
189	9	3	10	10	80
199	3	10	10	10	83
215	6	9	7	7	73

Laboratory No.	C 1252/T304 Uncompacted Void Content	D 2419/T176 Sand Equivalent	ASTM D 5821 % Fractured Particles	ASTM D 4719 % Flat & Elongated	Rating
216	10	9	8	10	93
232	10	10	10	9	98
235	9	10	10	9	95
236	10	8	10	9	93
245	10	10	7	9	90
263	9	8	10	9	90
269	10	5	10	10	88
271	9	8	10	6	83
272	10	10	5	10	88
273	0	8	10	8	65
285	8	10	10	9	93
293	9	10	9	10	95
295	9	7	8	10	85
316	6	10	9	10	88
325	0	8	4	6	45
327	10	6	10	9	88
328	10	10	10	9	98